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CHARACTERISTIC DESIGN FACTORS FOR PROPELLER AND KAPLAN TURBINES.

By J. R. FINNIECOME, M.Eng., M.I.Mech.E., M.Soc.C.E.

IN this comprehensive analysis, the writer carries a step farther his investigation on "The Development of Kaplan Turbines," published in the issue of ENGINEERING for November 15, 1940, page 381, in order to establish and to present the essential characteristic design factors. A series of new formulæ will be introduced and useful graphs will correlate, on an analytical and empirical basis, the design data and the parameters of propeller and Kaplan turbines. Moreover, these graphs have been prepared to predict easily and rapidly, and with reasonable accuracy, the principal dimensions and the velocity ratios influencing the particular design. There is no doubt that such graphical presentations do eliminate the usually laborious calculations; furthermore, they minimise considerably the possibility of errors. It is apparent that such charts offer a convenient method of determining the various factors which have a marked influence on design. The major object of the present analysis is to bring out the essential relationships between the various design factors and parameters based on actual turbines presented in the previous contribution. It seems opportune, therefore, to review the principal formulæ for propeller and Kaplan turbines having characteristic speed numbers n_s (English) of approximately 80 and above.

In the course of this analysis the writer will call attention to the chief points of interest, particularly to the important dimensions and factors. These will be examined in the light of recent experience under a series of headings.

(1) *The Characteristic Speed Numbers.*—Three types of expressions will be considered in this analysis:—

(*a*) *Camerer's Value.*—Applying first of all the most widely adopted formula for the characteristic speed number

$$n_s = \frac{n\sqrt{N}}{H^{\frac{5}{4}}} \quad . \quad . \quad . \quad (1)$$

where n_s = characteristic speed number in English units, n = speed of turbine in revolutions per minute, N = output at the turbine coupling in brake horse-power, and H = head in feet. Substituting

$$N = \frac{Q \cdot H \gamma \eta_T}{550} \quad . \quad . \quad . \quad (2)$$

where Q = quantity of water in cubic feet per second, γ = density of water (62·288 lb. per cubic foot), and η_T = turbine efficiency, we obtain consequently the following modified expression for

$$n_s = 0{\cdot}3365\, n \frac{Q^{\frac{1}{2}} \cdot \eta_T^{\frac{3}{4}}}{H^{\frac{3}{4}}} \quad . \quad . \quad . \quad (3)$$

The relationship of Q, H, n and η_T is presented graphically in Fig. 1. A typical example is indicated by the dotted lines and the arrows. It is worth while to recall here that by introducing the ratio of the dimensions and the velocities, into the basic formula, one arrives at the formula (2) published in the previous article, above referred to, on page 381, and presented in Fig. 4, on page 383.

(*b*) *Characteristic Speed Number* K_s.—We shall now refer to the characteristic speed number denoted by K_s, published by the writer in ENGINEERING for September 6, 1940, on page 196, as

$$K_s = \frac{n^2 Q}{(2g\,H)^{\frac{3}{4}}} \quad . \quad . \quad . \quad (4)$$

where n is the speed in revolutions per minute. This expression may be regarded as non-dimensional, except for the speed, which, however, would have to be expressed in revolutions per second. As this speed is generally in revolutions per minute, the writer prefers to use this formula rather than the value for k_s, which will be referred to later. Substituting the numerical value for the gravitational

Fig. 1.

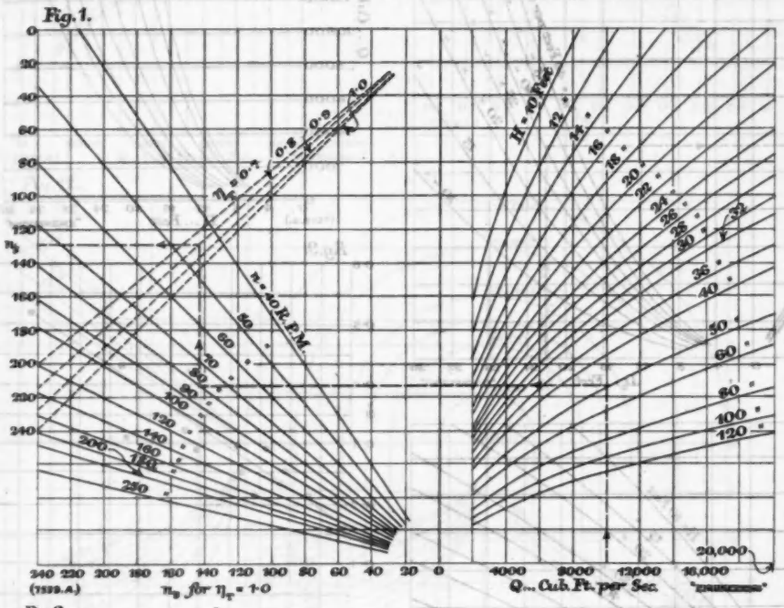
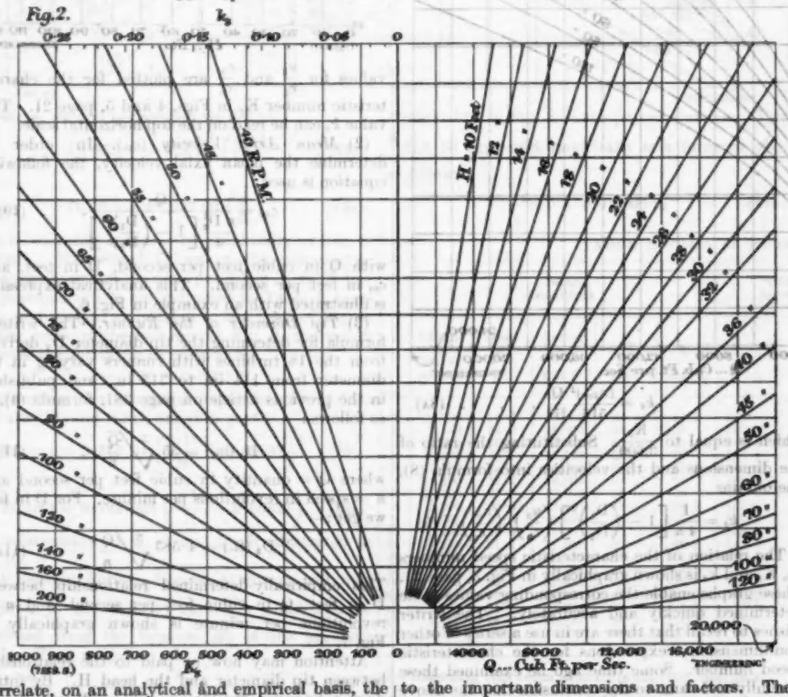


Fig. 2.



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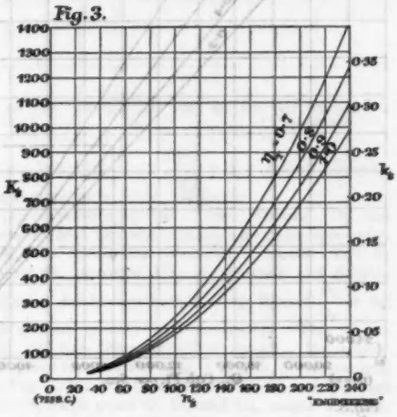

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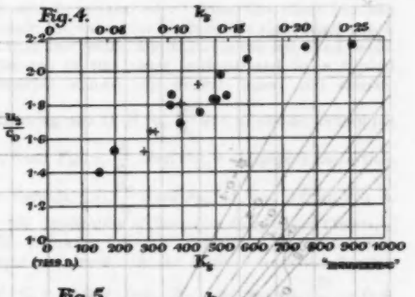

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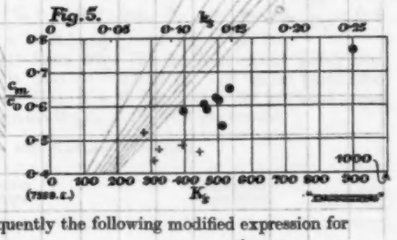


CHARACTERISTIC DESIGN FACTORS FOR WATER TURBINES.

Fig. 6.

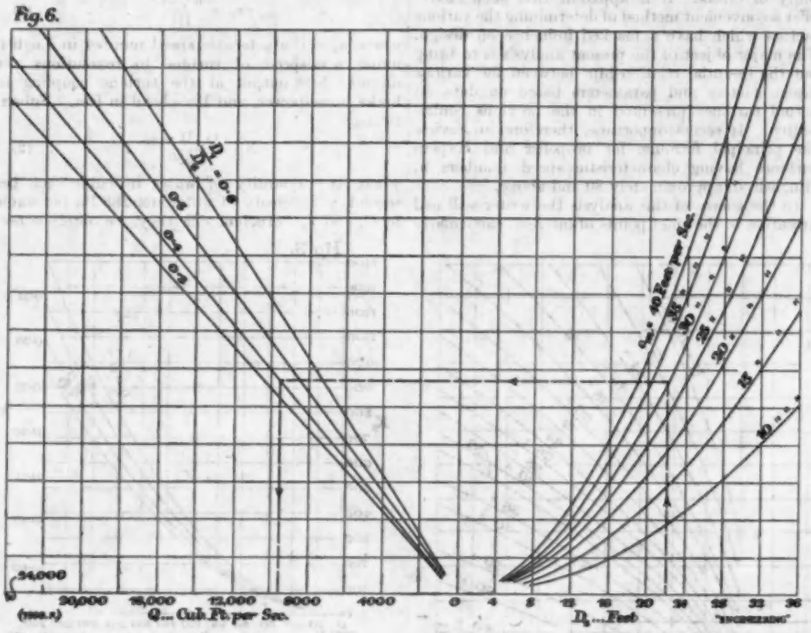


Fig. 7.

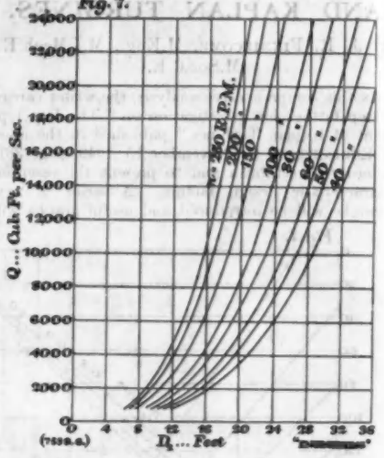


Fig. 9.

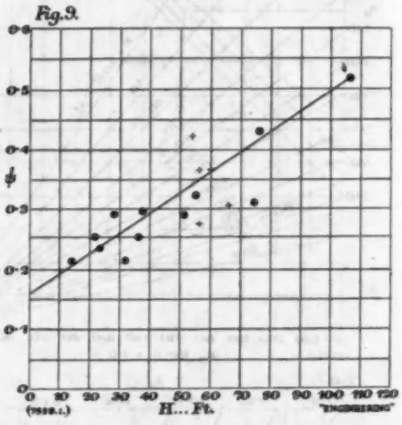
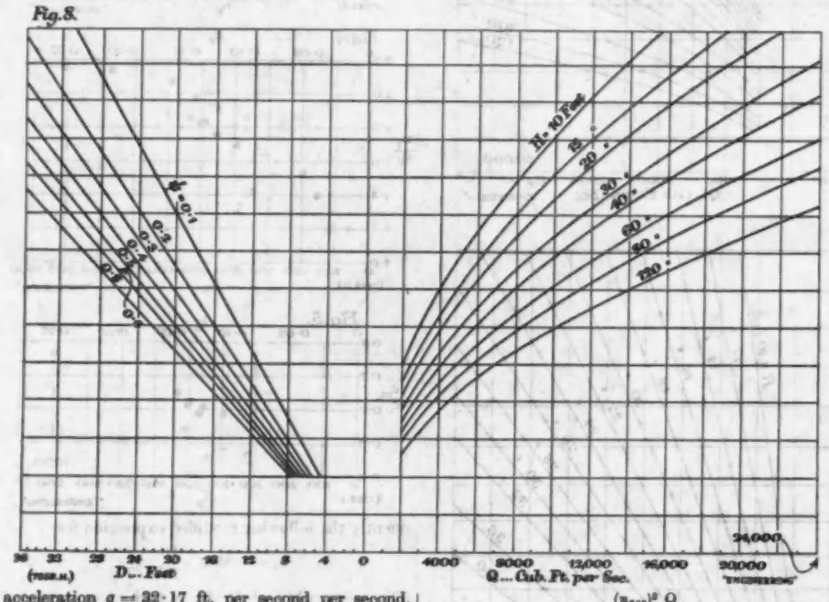


Fig. 8.



acceleration $g = 32{\cdot}17$ ft. per second per second, one thus gets:

$$K_s = \frac{n^2\ Q}{516\ H^{\frac{3}{4}}} \quad . \quad . \quad . \quad (5)$$

This expression is demonstrated graphically in Fig. 2, page 21, and an example is indicated by the dotted lines and by the arrows. The relationship or n_s (English) to K_s is expressed as follows:

$$n_s\ (\text{English}) = 7{\cdot}642\ \eta_T^{\frac{1}{2}}\ K_s^{\frac{1}{2}} \quad . \quad (6)$$

Introducing into formula (4) the ratio of dimensions and the velocities one obtains the following expression, published on page 196, Table I, formula (2*c*):—

$$K_s = \frac{900}{n}\left[1 - \left(\frac{D_2}{D_1}\right)^2\right]\left(\frac{u_2}{c_0}\right)^2\left(\frac{c_m}{c_0}\right). \quad (7)$$

(*c*) *Non-Dimensional Characteristic Speed Number* k_s.—Expressing n in revolutions per second in formula (4), one arrives ultimately at the non-dimensional value for the characteristic speed number:

$$k_s = \frac{(n_{sec})^2\ Q}{(2\ g\ H)^{\frac{3}{4}}} \quad . \quad . \quad . \quad (8)$$

or

$$k_s = \frac{(n_{sec})^2\ Q}{516\ H^{\frac{3}{4}}} \quad . \quad . \quad . \quad (8A)$$

which is equal to $\frac{K_s}{3{,}600}$. Substituting the ratio of the dimensions and the velocities into formula (8), one obtains

$$k_s = \frac{1}{4\ n}\left[1 - \left(\frac{D_1}{D_2}\right)^2\right]\left(\frac{u_2}{c_0}\right)^2\left(\frac{c_m}{c_0}\right). \quad (9)$$

The relation of the characteristic speed numbers n_s, K_s and k_s is shown graphically in Fig. 3, page 21. These graphs enable the corresponding values to be determined quickly and accurately. The writer wishes to recall that there are in use a series of other non-dimensional expressions for the characteristic speed number. Some time ago he examined these carefully and came to the conclusion that the above expression k_s is especially well suited to correlate in a very simple manner the principal factors as indicated by formula (9). The characteristic speed numbers n_s, K_s and k_s, and the design values for the 18 turbines, summarised in Table I, page 382, of the previous article, are recorded in Table I, opposite. The values for $\frac{u_2}{c_0}$ and $\frac{c_m}{c_0}$ are plotted for the characteristic number K_s in Figs. 4 and 5, page 21. The value k_s can be read on the top horizontal scale.

(2) *Mean Axial Velocity* (c_m).—In order to determine the mean axial velocity, the following equation is used:

$$c_m = \frac{Q}{\frac{\pi\ D_2^2}{4}\left[1 - \left(\frac{D_1}{D_2}\right)^2\right]}. \quad . \quad (10)$$

with Q in cubic feet per second, D in feet, and c_m in feet per second. This analytical expression is illustrated with an example in Fig. 6.

(3) *Tip Diameter of the Runner.*—The writer's formula for determing the tip diameter D_2 derived from the 18 turbines with runners varying in tip diameter from 114 in. to 315 in., and published in the previous article on page 381, formula (4), is as follows:

$$D_2\ (\text{in.}) = 55\sqrt[3]{\frac{Q}{n}} \quad . \quad . \quad (11)$$

where Q = quantity in cubic feet per second and n = speed in revolutions per minute. For D in feet we get:—

$$D_2\ (\text{ft.}) = 4{\cdot}583\sqrt[3]{\frac{Q}{n}} \quad . \quad . \quad (11A)$$

This empirically-determined relationship between D in feet, Q in cubic feet per second, and n in revolutions per minute is shown graphically in Fig. 7.

Attention may now be paid to the relationship between tip diameter and the head H. By introducing, however, the manometric coefficient

$$\psi = \frac{H}{\left(\frac{u_2^2}{2\ g}\right)} \quad . \quad . \quad . \quad (12)$$

where H is the head in feet, u_2 the tip speed in feet per second, and g the gravitational acceleration

CHARACTERISTIC DESIGN FACTORS FOR WATER TURBINES.

Fig. 10.

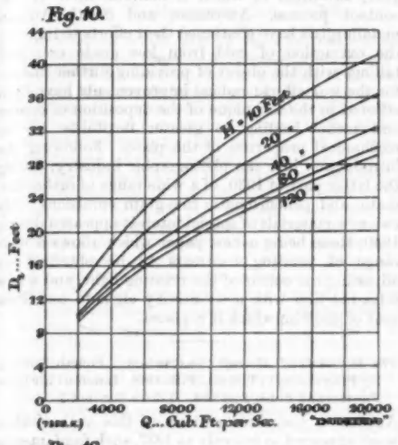


Fig. 11.

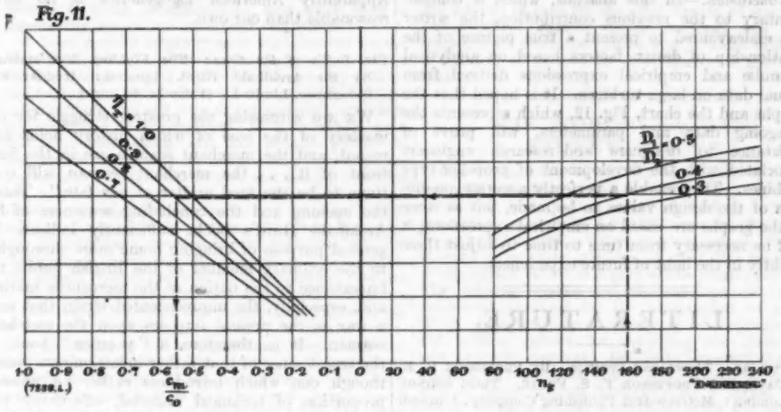
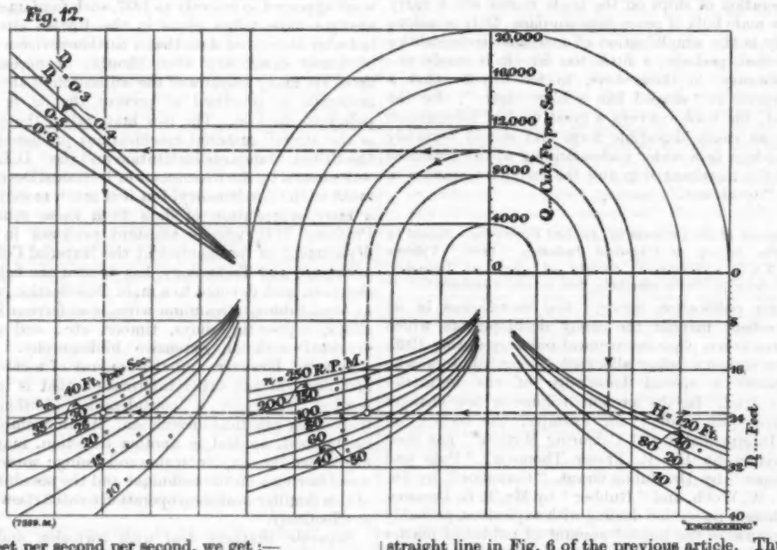


Fig. 12.



in feet per second per second, we get :—

$$D_2 \text{ (in.)} = 9{\cdot}512\ Q^{\frac{1}{2}} \left(\frac{\psi}{H}\right)^{\frac{1}{4}} \quad . \quad (13)$$

or

$$D_2 \text{ (ft.)} = 0{\cdot}7927\ Q^{\frac{1}{2}} \left(\frac{\psi}{H}\right)^{\frac{1}{4}} \quad . \quad (13A)$$

This relationship is indicated graphically in Fig. 8, opposite. The actual values of the manometric coefficient based on the data published in Table I of the previous article are indicated in Table I, herewith, and plotted in relation to the head of Fig. 9. On the basis of the full line in Fig. 9, the writer deduced the following expression for

$$\psi = 0{\cdot}16 + 0{\cdot}0033\ H.$$

By inserting this empirical expression for ψ into formulæ (13) and (13A), one thus gets

$$D_2 \text{ (in.)} = 9{\cdot}512\ Q^{\frac{1}{2}} \left(\frac{0{\cdot}16}{H} + 0{\cdot}00337\right)^{\frac{1}{4}} \quad (15)$$

or

$$D_2 \text{ (ft.)} = 0{\cdot}7927\ Q^{\frac{1}{2}} \left(\frac{0{\cdot}16}{H} + 0{\cdot}00337\right)^{\frac{1}{4}} \quad (15A)$$

The relationship of Q, H and D_2 is illustrated in Fig. 10.

(4) *Velocity Ratios.*—Special attention will now be given to the velocity ratio $\frac{c_m}{c_0}$, which can be calculated from the formula (2) of the previous article. Thus we get

$$\frac{c_m}{c_0} = \frac{n_s^2}{(129{\cdot}3)^2 \left[1 - \left(\frac{D_1}{D_2}\right)^2\right] \left(\frac{u_2}{c_0}\right)^2 \cdot \eta_T} \quad . \quad (16)$$

Now the relationship between n_s and the average value for $\frac{u_2}{c_0}$ is demonstrated graphically by a straight line in Fig. 6 of the previous article. Thus $\frac{u}{c_0}$ can be expressed empirically as a function of n_s as follows :

$$\frac{u_2}{c_0} = 0{\cdot}4 + 0{\cdot}0095\ n_s \quad . \quad . \quad (17)$$

By inserting this term into formula (16), one gets :

$$\frac{c_m}{c_0} = \frac{n_s^2}{(129{\cdot}3)^2 \left[1 - \left(\frac{D_1}{D_2}\right)^2\right] (0{\cdot}4 + 0{\cdot}0095\ n_s)^2 \cdot \eta_T} \quad . \quad . \quad (18)$$

This expression is presented in the form of a series of graphs in Fig. 11 for $\frac{D_1}{D_2} = 0{\cdot}3, 0{\cdot}4, 0{\cdot}5$, generally used on propeller type turbines.

(5) *Correlation of the Design Factors.*—On the basis of these formulæ and their graphical presentation, the writer has prepared a useful chart to enable the principal data on propeller and Kaplan turbines, for known values of Q, H and $\frac{D_1}{D_2}$ to be determined quickly and accurately. This chart, Fig. 12, has three principal panels: the centre one gives the relation of Q, n and D_2 corresponding to Fig. 7, the right-hand panel Q, H and D_2, and the left-hand panel Q, D_2 and C_m, based on Figs. 10 and 6, respectively. From this chart one can obtain the values for D_2 from the right-hand panel, n from the centre, and C_m from the left-hand panel. The use of this chart is illustrated by a typical example shown by dotted lines and arrows. Knowing now Q, H, η_T, $\frac{D_1}{D_2}$ and n, we can determine n_s from Fig. 1, $\frac{u_2}{c_0}$ from Fig. 6 of the previous article or formula (17), $\frac{c_m}{c_0}$ from Fig. 11, and ψ from Fig. 8.

(6) *Application of Formulæ, Graphs and Charts.*—The following example will suffice to demonstrate their usefulness. On the basis of an assumed value of Q = 10,000 cub. ft. per second, $\frac{D_1}{D_2} = 0{\cdot}4$, H = 40 ft., and $\eta_T = 0{\cdot}85$, we get :—

(1) From Fig. 12—(*a*) Right-hand panel (formula 15A), D = 23·23 ft.; (*b*) centre panel (formula 11A), n = 76·83 r.p.m.; (*c*) left-hand panel (formula 10), c_m = 28·10 ft. per second.

TABLE I.—DATA OF PROPELLER AND KAPLAN TURBINES.

	Design Conditions.					Characteristic Speed Numbers.			Characteristic Design Ratios.				
	Volume Q. Cub. Ft. per sec.	Head H. Ft.	Rating N. B.H.P.	η_T Per cent.	n R.P.M.	n_s.	K_s.	k_s.	$\frac{D_1}{D_2}$	$\frac{u_2}{c_0}$	$\frac{u_m}{c_0}$	$\frac{c_m}{c_0}$	ψ.
1	11,090	14·0	15,200	86·46	46·9	213·5	902·5	0·2507	0·3365	2·149	1·436	0·7698	0·2166
2	7,150	32·0	21,000	81·06	100	190·4	765·4	0·2126	—	2·143	—	—	0·2176
3	7,620	26·9	19,000	81·86	75	168·8	595·0	0·1653	—	2·059	—	—	0·2357
4	10,240	36·1	37,500	80·59	75	164·1	514·7	0·1430	0·3963	1·981	1·383	0·5417	0·2548
5	5,860	28·0	16,000	86·12	83·3	163·6	531·5	0·1476	0·4014	1·849	1·295	0·6464	0·2925
6	10,400	37·7	38,700	87·17	75	158·0	489·5	0·1360	0·4275	1·833	1·309	0·6217	0·2976
7	10,600	27·7	37,600	83·10	75	155·7	499·0	0·1386	0·4275	1·833	1·309	0·6336	0·2976
8	5,000	56·0	28,000	88·31	138·5	151·3	443·4	0·1232	0·2810	1·907	1·221	0·4616	0·2750
9	8,000	55·0	42,500	85·30	109·1	150·2	452·6	0·1257	0·3932	1·759	1·225	0·6023	0·3229
10	3,130	51·0	15,000	82·99	167	150·1	464·6	0·1290	0·4452	1·857	1·342	0·5859	0·2899
11	5,155	21·3	11,200	90·08	62·5	144·5	396·9	0·1102	0·4057	1·679	1·180	0·5875	0·3544
12	5,700	66·0	37,500	88·02	138·5	142·6	395·2	0·1098	0·3436	1·807	1·213	0·4779	0·3060
13	2,670	74·5	18,200	80·80	214	131·9	368·5	0·1024	—	1·793	—	—	0·3108
14	5,400	60·0	32,000	87·21	120	128·5	324·1	0·0900	0·3436	1·643	1·104	0·4749	0·3704
15	2,500	56·0	14,000	88·31	163·6	126·3	309·4	0·0860	0·3040	1·652	1·077	0·4353	0·3663
16	6,600	54·0	36,600	90·69	93·7	122·5	283·1	0·0786	0·4452	1·531	1·107	0·5240	0·4263
17	1,412	76·0	10,700	88·06	214·0	98·7	189·1	0·0525	—	1·521	—	—	0·4321
18	3,040	106·0	33,000	90·95	167·0	89·2	150·3	0·0418	—	1·389	—	—	0·5186

(2) From Fig. 1 (formula 3), n_s=149·9; Fig. 2 (formula 5), K_s=452·2; Fig. 3 (formula 8A), k_s=0·126; Fig. 6, previous article, page 384 (formula 17), $\frac{u_2}{c_0}$ = 1·824; Fig. 11 (formula 18), $\frac{c_m}{c_0}$ = 0·566; (formula 2), N = 38,500 brake horse-power. It

should be noted that the turbine will have to be designed for 75 r.p.m. to suit the alternator.

Conclusion.—In this analysis, which is complementary to the previous contribution, the writer has endeavoured to present a true picture of the relationship of design factors based on analytical formulæ and empirical expressions derived from actual data on large turbines. It is hoped that the graphs and the chart, Fig. 12, which represents the foregoing data and parameters, will prove of assistance to designers and research engineers associated with the development of propeller-type turbines. They enable a perfectly accurate prediction of the design values to be made, but as some of the graphs are based on empirical expressions, it will be necessary from time to time to adjust these slightly in the light of future experiences.

LITERATURE.

Surveying: Theory and Practice. By PROFESSOR R. E. DAVIS and PROFESSOR F. S. FOOTE. Third edition. London: McGraw-Hill Publishing Company, Limited. [Price 35*s.*]

THIS third edition of a work published in 1928 has been revised to bring it up to date, particularly as regards improvements in instruments. With a subject such as surveying, much of the work is as standardised as bricklaying or simple arithmetic and the bulk of the volume must therefore repeat what has already been recorded in previous books. The chapters follow the usual course of text-books on the subject and cover all necessary information on general routine and the use and adjustment of instruments. There is a noticeable difference between English and American text-books on surveying as regards field records; American practice seems to favour a much ruled book. Clear writing and sketching are necessary, but a surveyor has to work in high winds, damp weather and other adverse conditions and we suggest that it is better to leave him to space his sketches and notes so as to ensure that they are intelligible. This requires a flexibility which the much-ruled pages illustrated by the authors do not encourage; the illustrations are, in fact, rather unconvincing, and savour too much of the class room. We prefer the English type of field book with two lines down the centre to form a column and the rest of the page blank. The authors discard the chain in favour of the steel tape. The tape has some advantages in open level ground, such as town lands, but it is fragile and likely to get kinked and snap. Over rough ground, through English hedgerows, or in an Eastern jungle, there is much to be said in favour of the more sturdy chain, and in muddy ground it is quicker to read the tabs on a chain than the figures on a steel tape. The authors allow for many technically trained helpers, but the more general experience is that a field survey here has to be carried out by one surveyor with the aid of comparatively unskilled labour. It would appear that the authors are thinking in terms of a student group, each member of which has to be given something to do, and they forget that labour economies have to be practised in actual work.

So far as instrumental work is concerned, American and English practice seem to be more or less in line. We find it difficult to agree with the authors that "for very small angles greater accuracy can be obtained by taping than by ordinary measurement with a transit," especially if this is to be read in conjunction with their reference to section 128 of their book. An ordinary transit will read to 20 seconds of arc and thus give a maximum error of 10 seconds, which represents an offset of about $\frac{1}{4}$ in. at the end of a 100-ft. tape. It is not easy to align a tape truly within this degree of accuracy on ordinary rough ground, and the layout of a small angle will only have practical value if the alignment is true. There is a chapter on photogrammetric surveying which covers, as fully as one chapter will allow, this important modern development of survey work. Incidentally, if it is reasonable to cut one "l" from the English spelling of levelling, as Americans do, why substitute "photogrammetric surveying" for "photographic surveying"? The "metric" work is already implied in the word surveying, and, if a change is desired, it would be more logical and shorter to call it photosurveying. Apparently American logogenetics is no more reasonable than our own.

The Battle of the Seas: The Fighting Merchantmen. By Sir Archibald Hurd. London: Hodder and Stoughton, Limited. [Price 3*s.* 6*d.* net.]

"WE are witnessing the greatest struggle for the mastery of the seas of which history holds any record, and the merchant seamen are in the forefront of it . . . the merchant seaman will continue to be the final arbiter of our fate." These, the opening and the concluding sentences of Sir Archibald Hurd's book, sufficiently indicate its general purpose of bringing home more thoroughly to the ordinary member of the British public the importance to the nation of the mercantile marine, and, especially, the unprecedented strain that such a war as the present imposes upon the merchant seaman. It is, therefore, a "popular" book, in the truest sense of that rather indeterminate word; though one which introduces rather an unusual proportion of technical material, effectively presented and agreeably authoritative, regarding the operation of ships on the trade routes which carry the main bulk of peace-time supplies. Only occasionally is the simplification of maritime technicalities carried, perhaps, a little too far—it is surely unnecessary, in these days, to tell anyone that a torpedo is "shaped like a large cigar"; for the rest, the book conveys a great deal of information in an easily digestible form and should certainly conduce to a wider understanding of the functions of the merchant ship and the merchant seaman in a "total war."

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. 1940. Volume XXV. London: Society of Chemical Industry. [Price 7*s.* 6*d.* to members, 16*s.* to non-members.]

THIS publication surveys and summarises in an excellent manner the many developments which have taken place in chemical industry during 1940, the sections being allocated to contributors who possess a special knowledge of the industries involved. In the present volume a few changes have been made; for example, the section on "Intermediates and Colouring Matters" has been written by Dr. R. Fraser Thomson, "Pulp and Paper" by Dr. Julius Grant, "Ceramics" by Dr. H. W. Webb, and "Rubber" by Mr. T. R. Dawson. There is no section dealing with explosives, probably because of the limited amount of published matter relating to explosives technology which has appeared during the year under review. War-time restrictions have prevented the disclosure of much of the progress made, but have probably stimulated developments which would have taken far longer under normal conditions.

Gas undertakings operating under war conditions have had to meet with many difficulties, but in broad outline all the requirements of Government departments have been met on a voluntary basis, due largely to the national organisation of the industry, progress in which is discussed by Dr. H. Hollings and Mr. W. A. Voss. The manufacture of aviation fuels suitable for high-compression engines has been the outstanding development in petroleum technology during 1940. Considerable attention has also been given to the use of combustible gases in internal-combustion engines, with a view to substituting home-produced fuels for imported petroleum fuels. In view of the position regarding the supply of fuel oils in the United Kingdom, it would be in the national interest to convert oil-burning installations to use a heavier and cheaper grade of oil and to improve the design of such plants so as to increase their efficiency. A characteristic of the times is the erection of a small plant at Houston, Texas, by the Shell Company to produce toluene by aromatising the heptane content of suitably cracked gases at the rate of two million gallons per annum.

Dr. Thomson gives an extended account of azo dyes and dyes derived from polycyclic systems. Activity in the field of triphenylmethane and xanthene dyes continues and on the preparation of water-soluble anthraquinone dyes suitable for dyeing acetate rayon. The demand for sulphuric acid in this country has now reached two million tons a year, two-fifths of which is manufactured by the contact process. Australian and South African metallurgists have continued their efforts to improve the extraction of gold from low grade ores and tailings with the object of providing further finance for the war effort; radical improvements have been effected in the technique of the deposition of copper and nickel leading to greater flexibility in the mechanical properties of the plate. Following the introduction into the photographic industry, during the latter part of 1939, of a wide range of orthochromatic and panchromatic fine-grain emulsions, only two new materials of special interest appeared during 1940, these being a new paper which allows a wide range of printing contrasts to be obtained by adjusting the colour of the printing light, and a new infra-red film with a sensitivity eight to ten times that of the film which it replaces.

The Materials of Aircraft Construction. Fourth Edition. By PROFESSOR F. T. HILL, F.R.Ae.S. London: Sir Isaac Pitman and Sons, Limited. [Price 20*s.* net.]

ALTHOUGH the third edition of this authoritative work appeared so recently as 1937, such fundamental changes have taken place in the British aircraft industry since that date that a further revision was obviously desirable; even though, of necessity, there are many features of the utilisation of aircraft materials as practised at present that it is not policy to disclose. The raw material of the book is the aircraft-material specifications published by the British Standards Institution and the "D.T.D." series issued by the Directorate of Technical Development at the Air Ministry, but it is much more than a mere compilation of data from these sources. Professor Hill, who is assistant professor in the department of Aeronautics at the Imperial College of Science and Technology, has divided the field in chapters, each devoted to a main classification, such as steel tubing, streamline wires, non-ferrous light alloys, copper-tin alloys, timber, etc., and each provided with an extensive bibliography. His comments, however, and the amount of incidental metallurgical and other information that is interpolated, represent a considerable addition of thoroughly practical instruction. As an example of his method, applied in another direction, may be mentioned the chapter on glue and gluing; we do not recall having seen the technique and the possibilities of this familiar workshop operation treated elsewhere so effectively.

Separate chapters deal with corrosion and its prevention, varnishes, rubber, and fabrics and dopes, and some preliminary consideration is also given to the mechanical testing of materials. Up to this point, the book may be said to be addressed chiefly to the constructor, particular attention being given to the intelligent working of the various materials; but the concluding chapter, and the three appendixes which follow it, concern rather the designer, who must select the materials for given conditions. Appendix I indicates, by description and by reference to the appropriate specifications, the materials suitable for use in the construction of the principal parts of typical aircraft and aero-engines; and the other two appendixes list, respectively, the British Standard Specifications for aircraft materials and components, and the D.T.D. Specifications. Altogether, this is an excellent book; readable enough to appeal to the comparative newcomer to the aircraft industry and yet sufficiently comprehensive and up-to-date to serve as a reference book for the more experienced man.

"CONCRETE PRODUCTS AND CAST STONE": CORRIGENDUM.—In reviewing the seventh edition of Mr. H. L. Childe's book, *Concrete Products and Cast Stone*, on page 497 of our issue of June 20, we commented on the fact that certain illustrations were reproduced from half-tone originals, to the detriment of their quality; but the inadvertent deletion of a qualifying phrase, during proof-reading, made this remark appear to apply to all the 146 half-tone illustrations. Actually, the majority were made from photographs specially taken for the purpose of this book and their reproduction left nothing to be desired. We regret this unintentional reflection upon a work of which, as the review indicated, we formed a very favourable opinion.

THE FUTURE GROUPING OF GAS UNDERTAKINGS.*

By W. MONCRIEFF CARR, O.B.E.

IF a review of the past 25 years has not convinced the majority of responsible administrators in the gas industry of the necessity for the grouping of gas undertakings, the circumstances arising from the life-and-death struggle upon which we are at present engaged will have brought realisation to many of the necessity for closer co-operation and working. It is, perhaps, unfortunate that the industry came into being on a parochial basis, and that the areas of gas undertakings were constructed to coincide with the areas of local boards of townships and parishes which were constituted lighting authorities. Throughout the last century, statutory limitations tended to operate against grouping and co-ordination in suitable geographical areas, however desirable or necessary it may have been. Another factor which has tended to restrict centralisation and amalgamation is that, while our services were originally solely for the purpose of providing illumination, our function has changed to that of a supplier of fuel; and because of innate conservatism —which almost inevitably exists in industries and other organisations of long standing—our outlook has tended to be restricted, and we have usually thought in terms of supplying relatively small quantities of gas per consumer.

Generally speaking, the gas consumer is not interested in the undertaking from which he receives his supply; he buys a commodity with its accompanying service, and his estimation and appreciation of gas service as a whole is dependent upon what he receives. It is essential, if the industry is to expand—as it should and must in a country so rich in bituminous coal—that the gas supply service in all areas, rural, suburban, and metropolitan, should be maintained on an equitably high standard. This implies a better distribution of highly-trained and specialist brains in the industry generally. The day of the small undertaking operating as a separately-controlled unit in a restricted area has passed, and the problem of co-ordination and grouping of all such units must be a first consideration after the war. The problem of post-war reconstruction is dependent, to a great extent, upon fuel, and the national plan must provide for the economic use of coal.

The gas industry must fight for proper recognition of the service and function it can fulfil, not operating as it has done with a multiplicity of small undertakings serving restricted areas with gas at relatively high prices, but amalgamated and grouped for the centralisation of manufacture in large and economic gas-making units, linked up to ring-main distribution systems, to ensure a supply of constant quality, purity and pressure. No less important is the technical service to be rendered to the consumer, both domestic and industrial, and finally, co-ordination of sales and commercial activity. It cannot be gainsaid that the electrical grid has proved of great advantage in raising the standard of electricity supply, particularly in urban and rural areas, and while some of the larger electrical undertakings have complained that the grid has brought little direct advantage to them, I believe it is appreciated that the improvement of electricity supply service is general throughout the country, and so proves of advantage to the industry as a whole.

In the gas industry we stand or fall together, and most of the efficient gas undertakings, however high a standard they have maintained, will frequently be measured by the less efficient service rendered by undertakings in other parts of the country. The greatest deterrent to grouping in the past has been a fear on the part of Local Authority committees, boards of directors, and managements, that their own positions may be disturbed or of less importance in a combined organisation. This is true in a measure with regard to the first two, but in such grouping as has been carried out, the tendency generally has been to increase the scope, and afford wider opportunities for service and experience to managements, both technical and administrative.

Grouping has, to some extent, been effected by the operation of holding companies, although the co-ordinated services provided vary from the almost negligible to extensive technical and sales service by centralised staffs. Grouping has also been effected by the acquisition of neighbouring small undertakings by their larger neighbours, and linking up, with most advantageous results. It is, in the author's opinion, desirable that definite area plans should be formulated for the purpose of grouping, and where justified by the density of population, the linking up of undertakings. In the case of the United Kingdom Gas Corporation Limited, a central organisation has been set up for the purpose of rendering specialist technical, administrative and sales assistance. Where neighbouring undertakings have been acquired, they have been, or were in the process of being, amalgamated; this latter work is temporarily suspended under war conditions.

A third method of grouping is that effected by the West Yorkshire Gas Distribution Company, which is the first undertaking of its kind in this country authorised to buy gas from coke ovens and gas undertakings, and distribute and sell only to gas undertakings which are connected to the system. It is operating as a statutory undertaking, and has already proved of inestimable advantage in maintaining existing gas plants at their maximum output, and making available not only cheaper gas, but, more important, gas of constant quality and purity, to the smallest undertakings connected to the system. The West Yorkshire Gas Distribution Company is now operating miles of high-pressure mains ranging in size from 4 in. to 18 in. The system operates with an initial maximum pressure of 35 lb. per square inch, and constituent companies of the United Kingdom Gas Corporation, Limited, are at present linked up to the system. In addition, coke-oven plants are or will be supplying purified gas to the distribution company. The retention of local coke markets in the areas of the undertakings which have ceased to manufacture, is provided for by arrangement to take coke on special merchants' terms from the ovens supplying gas. These arrangements are facilitated by the co-ordination already achieved through the National and District Coke Associations.

There are many areas where similar linking-up of companies might be carried out for the better and more complete utilisation of the largest and most efficient plants in the area, and the general improvement of gas service in the smaller areas. Such schemes need not necessarily envisage the use of coke-oven gas, but where coke-oven gas is available it could and should be brought into the system; in other words, carbonising plants, of both gas works and coke ovens, should be co-ordinated on a sound geographical basis. Distribution companies are a cheap and efficient method of effecting grouping in an easier way than by actual amalgamation.

In the case of Local Authority undertakings supplying gas to or taking from such a company, they could be represented by members appointed to the board of the company. This is not a new suggestion, and in the case of one amalgamation of a publicly-owned Gas Board serving two municipal boroughs and one urban district, and a neighbouring gas company also serving a borough and an urban district, the constitution of the amalgamated undertaking provided for the representation of the Local Authorities on the board of directors. This arrangement has proved most satisfactory in operation, and it is particularly advantageous in that the Local Authorities are kept fully informed by their own representative as to the conduct of the gas service in their area.

It has been indicated that there are within the industry very divergent views as to its scope in the future. The manufacture of gas in large units, and its distribution as a fuel for domestic and industrial purposes on the widest possible basis, will enable it to be sold at prices more than competitive with other fuels when all factors are taken into account, particularly efficiency and utilisation. Assuming that the necessity for grouping and co-ordination is generally admitted, the question will be asked: "How can it be effected, having regard to the existing structure of the industry, and will it be possible to overcome local prejudices and sectional interests?"

It would appear that, generally speaking, interests are so diverse that they can only be brought into line if a national scheme were prepared under the ægis of the appropriate Government department. Such a scheme would envisage the appointment of commissioners for the purpose of holding regional inquiries, and for formulating plans for definite regional groups. Such groups need not necessarily provide for the linking-up of the undertakings by high-pressure systems, although it is remarkable how this can be effected on an economic basis with a relatively small quantity of gas, as the costs of production in small units allow a substantial margin as a set-off against the cost of linking-up. Grouping might equally well be effected by holding companies which could be made statutory, by co-operative bodies such as joint boards providing common services of a technical and other specialised nature and co-ordinating commercial and sales policy in the group, or by a combination of these methods.

It would appear that, despite the heavy demands which war conditions at present make, we should apply our minds to this problem of post-war reconstruction forthwith, and that the necessary surveys might be put in hand by a co-ordinating committee or committees drawn from the national bodies as they exist at present. In this paper no attempt is made to indicate the many advantages that would result from co-ordinated working in geographical groups and areas. Not the least important is that it would result in the recruitment of a higher standard of personnel, and it would be possible to offer a proper reward to secure the services of men for the great variety of specialised duties which require special training, and whose employment would be spread over a wider field than is afforded at present in the majority of gas undertakings.

* Paper presented at the 78th annual meeting of the Institution of Gas Engineers, held in London on June 11, 1941. Abridged.

THE WORONORA DAM, SYDNEY, N.S.W.*

THE construction of the Woronora dam is over 90 per cent. completed. The four large dams which now serve the metropolitan area of Sydney, with its population of nearly 1,500,000, are in the Upper Nepean catchment. Woronora will supply Sydney through a separate pipeline, so that the margin of safety against failure of supply will be greatly increased. The original scheme for the development of this catchment provided for the construction of a dam 60 ft. high to form a reservoir of approximately 422 million gallons for supplying the Sutherland and Cronulla districts. In 1929, however, the programme was amended and it was decided to proceed with a larger scheme incorporating a 200-ft. dam. Owing to the financial stringency, work was stopped in March, 1931, and was not resumed until the end of 1936. Excavation for the spillway channel commenced seriously in February, 1936, and excavation for the dam foundations was resumed in September, 1936. Concreting was commenced in April, 1937. The dam is a mass-concrete structure of gravity section, curved in plan, with a crest length of 1,300 ft. It will be 217 ft. high above foundation level and will impound approximately 15,800 million gallons. The general particulars of the undertaking are as follows:—

Dam.

Length of crest	1,300 ft.
Thickness at crest	20 ft.
Max. thickness at base	185 ft.
Height above general foundations	217 ft.
Max. depth of cut-off trench	53 ft.
Radius of curvature at vertical up-stream face	1,200 ft.
Quantity of concrete	434,000 cub. yd.
Quantity of excavation	151,000 cub. yd.

Spillway.

Quantity of excavation	406,000 cub. yd.
Quantity of concrete	12,500 cub. yd.
Length of spillway weir	500 ft.
Length of spillway channel	1,250 ft.
Width of spillway channel at invert	30 ft.
Max. depth of spillway channel	150 ft.
Spillway capacity	36,000 cusecs
Surface area of reservoir	937 acres
Storage capacity	15,800 million gallons
Safe draught	12 million gallons a day
Catchment area	29 sq. miles
Mean annual rainfall	42 in.
Diameter of steel pipes	48 in.
Length—Woronora dam to Penshurst	16·1 miles

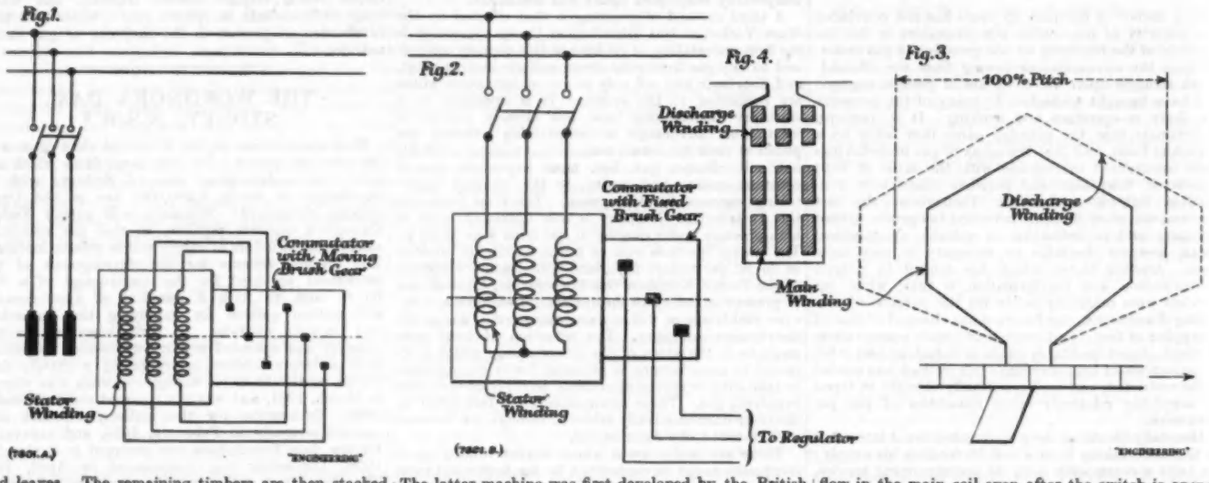
After completing the excavation in the river bed, a large number of deep holes were drilled in the floor of the cut-off trench and over the remainder of the foundations. Into these holes liquid cement was pumped to seal up any cracks or fissures in the underlying rock strata. The rock surface was then made spotlessly clean by means of compressed air and water jets, after which concreting was commenced. The various sizes of stone and sand are drawn through "gates" from the storage bins and conveyed on travelling belts to a weighing machine, where the ingredients for each batch are automatically weighed. Having been weighed, the aggregates are discharged into a truck; an operator in a cabin near the top of the building which houses the mixer equipment, presses a button and the batch is hauled up a steep incline, automatically tipped, and run through a series of chutes to the mixers. After the concrete has been mixed it is run into large skips, each of which carries two batches totalling 6 tons, and the skips are then drawn under the cableways which transport them rapidly overhead to the dam. In normal operation the plant mixes and places two tons of concrete every minute.

The impounding of about 15,800 million gallons of water by the dam across the Woronora River will result in the submergence of an area of one thousand acres of river valley. This area, originally heavily wooded, is being cleared to prevent pollution of the water. Trees are felled, the larger ones broken up by blasting, and the undergrowth is cut down. After a short interval for drying, a running fire is allowed to pass over the area to burn off the small branches

* From *The Commonwealth Engineer*, May 1, 1941. Abridged.

COMMUTATING WINDINGS FOR ALTERNATING-CURRENT MACHINES.

MESSRS. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, RUGBY.



and leaves. The remaining timbers are then stacked and burnt. The men employed on this work are conveyed daily by launch from their headquarters at the dam to their bases of operations.

An inspection gallery runs longitudinally through the dam at a height of 60 ft. above the river bed. An additional gallery is being constructed along the rock foundation in the southern abutment where excavation has revealed very broken strata. The 36-in. outlet pipes through the base of the dam are controlled at the upstream end by timber stopboards, emergency roller gates and penstocks. At the downstream end, the outlets are connected to the 48-in. diameter steel delivery main which forms the Woronora pipeline, and are each controlled by a gate valve and a needle valve. A spillway channel, 30 ft. wide at the bottom and with a maximum depth of 150 ft., is being excavated through a spur to provide for a maximum flood discharge of 36,000 cusecs. This channel will be concrete-lined up to above flood level.

For the past eight years the dam has been a source of supply for the Sutherland-Cronulla district. A 48-in. diameter steel main, about 16 miles in length, is now under construction. It will feed the Penshurst reservoir, with offtakes to Engadine and Sutherland reservoirs. At a later stage it will be extended to Waterloo pumping station. The works have been designed by the engineering staff of the Metropolitan Water Supply, Sewerage and Drainage Board of Sydney under the supervision of Mr. S. T. Farnsworth, engineer-in-chief.

AUXILIARY COMMUTATING WINDINGS IN ALTERNATING-CURRENT COMMUTATOR MACHINES.

THE first phase-advancer and variable-speed alternating current commutator motor to be constructed in this country were made by Messrs. The British Thomson-Houston Company, Limited, Rugby, in 1913 and 1916, respectively. Since then many thousands of alternating-current commutator machines of all kinds have been giving good service for periods of many years. Certain types of machines, notably the phase advancer and the Scherbius regulating motor, can have their magnetic circuits arranged with salient poles and interpoles, similar to those of a direct-current machine, and by this means the flux in the commutating zone, and hence the commutation, can be controlled. The majority of polyphase commutator machines, however, are constructed so that their operation depends on the production of a rotating field as in an induction motor, and interpoles therefore cannot be used. Where the brushes of the machine are movable, this fact in itself makes it impossible to use interpoles, but even in those machines which have fixed brush-gear, the provision of interpoles is not generally feasible, because this would cause undue distortion of the main rotating flux.

The two principal types of commutator machine in which interpoles cannot be used are the Schrage variable-speed motor controlled by means of movable brushes, and illustrated diagrammatically in Fig. 1, and the stator-fed motor which is generally controlled by means of a separate induction regulator; see Fig. 2. The latter machine was first developed by the British Thomson-Houston Company in 1934 and some hundreds have been made since that time. The experience gained has led to the conclusion that the Schrage motor, which is self-contained and gives better operating characteristics, is preferable to the stator-fed motor for the majority of general applications. There are, however, a considerable number of cases where the rating, or the conditions of use (for example, a high-voltage supply or the need for remote control on small motors) give the stator-fed motor an advantage. While there is a definite technical limit to the horsepower for which each type of motor can be built at any speed, this limit is rather higher in the case of the stator-fed motor. The construction of the latter also has some advantage for totally-enclosed fan-cooled motors. Hence there is a definite field for both types of motor, and it is desirable to be able to consider each machine on its merits for any particular case.

Large numbers of motors of each type have been constructed satisfactorily without the use of any special commutating winding, relying only on the action of the brush contact to obtain good commutation. Limits have, however, been determined by experience which must not be passed if satisfactory results are to be obtained. In the Schrage motor the commutator winding only handles the fraction of the total power corresponding to the speed regulation from synchronous speed, whereas the commutating winding of the stator-fed motor carries the whole output of the machine; and due to this fact commutation is inherently more difficult in the stator-fed motor. This partly explains why the Schrage motor has been the more widely used variable-speed alternating-current commutator motor.

For many years experiments have been carried out with various devices with the object of extending the design limits and obtaining increased outputs. One of the most successful of these was the use of high-resistance connectors between the winding and the commutator segments. None of these methods, however, could be compared in its effectiveness to the interpoles used on direct-current machines, as the benefit obtained was only a matter of 20 or 30 per cent. In recent years, damping windings of several types have been introduced which provide real control of the conditions of commutation, and it is the purpose of this article to describe some of the results obtained. Briefly, it may be said that the interpoles of a direct-current machine provide complete neutralisation of the voltage due to the change in the main current (reactance voltage), but do not compensate the high-frequency pulsations, while an effective damping winding, although it only partially damps out the reactance voltage, has also a damping action on the high-frequency pulsations. Hence an efficient damping winding can give improved results of the same order as are obtained by the use of interpoles.

The action of a damping winding can best be explained by comparing it with the discharge resistance connected across a switch used to open an inductive circuit such as a generator field winding. When the current in the coil is reduced from its initial value to zero by opening the switch, the flux linking the coils must also be reduced to zero if no discharge circuit is provided. This rapid change of flux induces a high voltage which causes the switch to arc, thus tending to prolong the period during which current flows. If there is a discharge circuit, current can continue to flow in the main coil even after the switch is opened, because the induced voltage passes a current through the resistance. Hence the rate of change of flux is considerably less and the danger of sparking is reduced. Energy which would otherwise cause an arc is dissipated in the discharge resistance.

The same action takes place in a coil of a commutator winding as the two segments to which it is connected pass under a brush. If the voltage induced in the coil, due to the change in the flux linking it, is greater than the total brush contact voltage which normally absorbs the energy of commutation, sparking will result when the circuit (which has been closed by the brush) is broken. By connecting a coil of a damping or discharge winding in parallel with the main coil, a circuit is provided in which current can continue to flow after the brush has ceased to short-circuit the segments, so that the flux linking the coil need not change as rapidly as it would have to otherwise. Some of the energy of commutation is thus transferred to the discharge resistance. It should be noted that the use of these discharge or damping commutating windings does not reduce the number of brushes on the commutator except to the limited extent to which the current density can be increased. The commutator voltage is limited by the losses due to circulating currents under the brush, and cannot be increased except at the expense of excessive temperature rise at low speeds. This applies to both the Schrage motor and the stator-fed motor. Further, both types must necessarily have approximately the same amount of brush gear, irrespective of the method of connection or whether there are two brush rings or only one. On the average, assuming equally safe designs, the stator-fed motor carries no fewer brushes than the Schrage motor for the same horse power and speed range.

In order to obtain the best results a damping coil must fulfil two conditions: (*a*) It must not be linked inductively with the main coil to which it is connected; and (*b*) there must be no, or only a small, circulating current due to the main flux of the machine in the closed path comprising the main coil and the damping coil. In all cases the balance of voltages between the main and discharge winding, both with regard to magnitude and phase, is maintained by suitable choice of the pitch of the coils and their location round the armature.

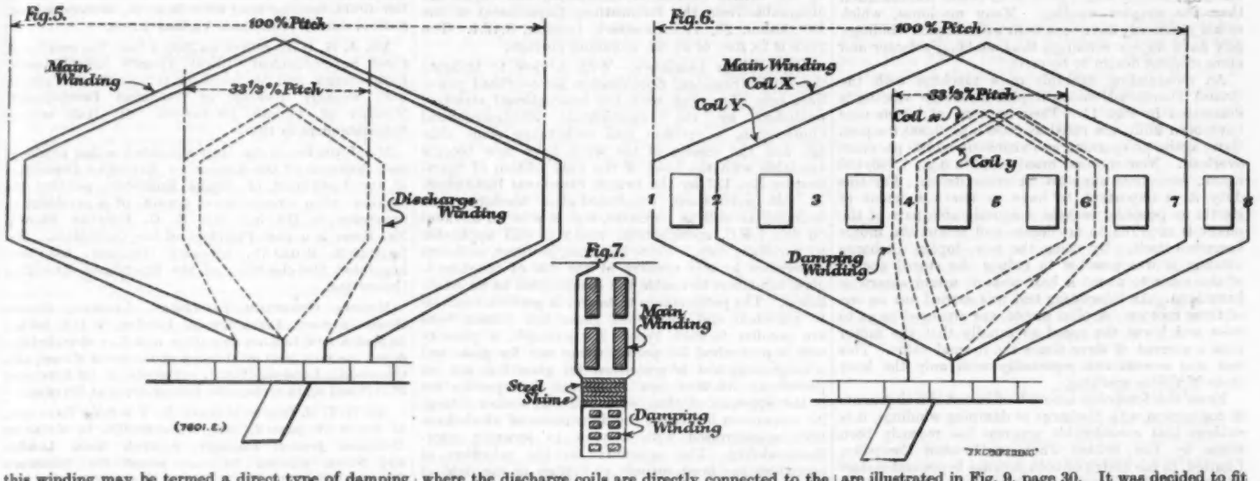
Three types of winding which fulfil these conditions and which have been used successfully are described below.

Robinson Discharge or Damping Winding.—In this arrangement,* due to Mr. P. W. Robinson, of Schenectady, the main coils are short-pitched, while the discharge coils are over-pitched by the same amount as the main coils are under-pitched; see Fig. 3. Thus both the above conditions are satisfied, since the two coils lie in different slots, and the total voltage round the combined circuit is zero. The discharge coil has a smaller section than the main coil and is wound at the top of the slot, Fig. 4, so that its resistance is greater and its inductance less than those of the main coil. The complete winding thus consists of two ordinary double-layer lap windings, one above the other and connected to the same commutator lugs. As the damping coil is directly connected to the main coil,

* B.T-H. Patent No. 518,047.

COMMUTATING WINDINGS FOR ALTERNATING-CURRENT MACHINES.

MESSRS. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, RUGBY.



this winding may be termed a direct type of damping winding.

Duplex Discharge or Damping Winding.—An extension of this scheme* applies the same principle to a duplex winding. Here the main coil is of full pitch, and is connected to segments two apart so as to permit a larger flux per pole to be used in the machine without exceeding the permissible voltage between adjacent segments. A second set of main coils is connected to the intermediate segments, thus forming a duplex winding. The discharge coil has a pitch of 33⅓ per cent., as shown in Fig. 5, and is located so that the voltage induced by the main flux in two turns is exactly equal to the voltage in one main coil. This winding is connected to every segment so that, in addition to its action as a discharge winding, it also serves to equalise the potential between the two circuits of the main duplex winding. Constructionally the arrangement is similar to that of the Robinson winding and it is also of the direct type.

Embedded Damping Winding.—A somewhat different arrangement is used in a winding described by Dr. B. Schwarz in *Elektrotechnik u. Maschinenbau*, February, 1934, and illustrated in Figs. 6 and 7. This type of winding has also been described in recent articles in the British technical Press. Here the auxiliary winding is placed at the bottom of the slot below the main winding, and separated from it by steel shims which complete local magnetic circuits around the conductors of the auxiliary winding. The main coils are of full pitch, while the auxiliary coil, connected in parallel with a main coil, consists of two turns each of 33⅓ per cent. pitch, so that the resultant voltage induced by the main flux has the same magnitude in two auxiliary turns as in one main coil. In addition the windings are arranged so that, considering two main coils lying in adjacent slots (coils X and Y, Fig. 6), the two corresponding auxiliary coils connected in parallel with them lie in the same slots as one another (coils x and y). By this means, every main coil is connected through a small transformer consisting of two auxiliary coils, to another coil in another slot; that is, the action is an indirect one. This second main coil constitutes the discharge circuit for the first main coil acting through the medium of the auxiliary transformer. In addition to the action as a discharge winding, a further benefit is obtained due to the fact that the discharge coil, in which a change in current is brought about during commutation of the preceding coil, is the next main coil to be commutated.

Comparison between Direct and Indirect Types of Damping Windings.—In recent years, The British Thomson-Houston Company has done a considerable amount of practical work on alternating-current commutator machines with damping windings, both of the direct type and of the indirect or embedded type, and has come to the conclusion that better results are obtained with the direct type of winding. The results, some of which are described below, include comparative tests on stator-fed motors with different types of winding, comparisons between Schrage and stator-fed motors, and a large amount of data on other machines obtained both in the works and in service. It is evident on theoretical grounds that, with a damping winding of the embedded type, the discharge action is a good deal less effective than in the first two cases, where the discharge coils are directly connected to the main coils. In the first place, the effective discharge resistance, instead of being the resistance of a single coil, consists of the resistance of a main coil added to the primary and secondary resistances of the transformer, each of which consists of two turns of the auxiliary winding. In the second place, some asymmetry is necessarily introduced by the method of connection, since, while the voltages in the two main coils X and Y, Fig. 6, are different in phase, because they lie in different slots, the voltages in the two auxiliary coils x and y are the same, and so cannot balance the main coil voltage in both cases. Thus, a certain amount of circulating current inevitably occurs with the winding illustrated in Fig. 6, and, as a result, a relatively high resistance in the auxiliary winding is necessary in order to limit the losses. In both of the direct types of discharge winding, on the other hand, there is an exact balance of voltages, so that the value of resistance can be chosen to obtain the most effective damping.

In order to prove the relative merits of the direct damping windings, Figs. 3, 4 and 5, and the embedded damping winding, Figs. 6 and 7, identical motors have been built, the only difference being in the type of discharge or damping winding. Fig. 8, page 30, shows the rotor of a stator-fed alternating-current commutator motor rated at 300/100 h.p., 1,120/320 r.p.m., 400 volts, 50 cycles, which is believed to be the largest horsepower per pole hitherto obtained in any machine of this type built in this country. This rating was above the permissible limit for a Schrage motor. As six identical machines were required it was decided to build the first two rotors with different types of damping winding and to adopt for the remaining four the type which proved the better. In both cases, the main winding was of the duplex type; but one was provided with an embedded auxiliary winding located at the bottom of the slot and similar to that indicated in Fig. 7, whereas the second rotor had a discharge winding at the top of the slot as shown in Fig. 4. Good commutation was obtained with both rotors, but the second one was appreciably better and this arrangement was adopted for the remaining four machines. With the winding at the bottom of the slot, there was noticeable sparking at top and bottom speeds. With the second machine using the discharge winding at the top of the slot, commutation was practically black at all speeds. In addition to its superiority in commutation, the rotor with the discharge winding on the top is easier to wind, and makes a much better mechanical job when complete. On a high-speed rotor, the steel shims in the slot, and the small winding underneath, on to which the main winding is pressed by the binding bands, introduce difficulties in the case of the embedded type of winding.

A further comparison has also been made between a stator-fed motor with embedded damping winding and Schrage motors of corresponding rating. Some Schrage motors have been built rated 125/65 h.p., 1,450/1,300 r.p.m., and another rated 100/36 h.p., 1,470/1,100 r.p.m. These motors did not require any special discharge or damping windings to get good commutation, and have been in service for several years giving satisfactory operation in each case. An opportunity arose for building a stator-fed motor rated at 130/40 h.p., 1,600/1,000 r.p.m., three phase, 3,300 volts, 50 cycles, the stator and rotor of which are illustrated in Fig. 9, page 30. It was decided to fit this with an embedded damping winding of the type illustrated in Figs. 6 and 7. The auxiliary winding was located at the bottom of the rotor slot below some steel strips as in Fig. 7 and was dimensioned to limit the circulating loss to a reasonable value. The commutation was about equal to that on the Schrage motors with simplex winding without a discharge winding, but not as good as would be obtained on a Schrage motor with a discharge winding. It was evident that this output would have been difficult to obtain from a stator-fed motor without the use of a damping winding.

During the last three years, over 100 motors of the Schrage variable-speed type have been constructed with discharge windings in the armature. All the damping windings used on Schrage motors have been of the direct type, either simplex or duplex; these are in addition to large numbers of smaller machines with simple lap or wave armature windings. Where the Robinson simplex type of discharge or damping winding has been used it has been mainly to give increased output to existing designs or increased overload capacity for severe duties. Many of the larger sizes of motor, which were formerly provided with the resistance connectors mentioned earlier, are now wound with discharge windings, and give better performance in addition to having a simpler mechanical construction. Although resistance connectors were of appreciable benefit in these machines, their main function was to reduce parasitic circulating currents under the brushes rather than to influence the commutation of the main current. Moreover, additional losses were introduced in the resistance winding itself. The Robinson winding, it may be noted, does not introduce any circulating current losses, but actually assists by carrying part of the main current. Fig. 10, page 30, shows a typical motor with this type of winding. The motor is rated 20/20 h.p., 1,200/400 r.p.m., 440-volt, 50 cycles, and is one of several supplied for driving large machine tools. The commutation of these machines was very good up to 100 per cent. overload.

It is correct to say that on those motors built so far with discharge windings, the commutation at twice full load has been superior to that of similar motors, without the discharge winding, running at full load or even less. It must be appreciated, however, that throughout the world there are in service very many thousands of Schrage motors of all sizes, on which the commutation must be regarded as satisfactory, even in those machines where visible sparking is present. Visible sparking does not necessarily mean injurious commutation, especially in the case of the Schrage motor, where the commutator only handles the slip power, and where the commutator voltages are very low. These conventional simplex windings will continue to be used on the small and medium-sized motors in the future, as there is no reason to depart from them. The duplex winding permits the use of increased fluxes and hence of increased output per pole. A Schrage motor of 270 h.p., using this type of winding, was constructed as early as 1925, and many other machines have been put into service since that time. The construction was, however, somewhat cumbersome and expensive, due to the fact that some means had to be provided for equalising the two sections of the winding, and it was only used for machines which could not be made with a simplex winding. The new

* B.T.-H. Patent No. 530,874.

duplex discharge winding illustrated in Fig. 5, however, provides, with a construction just as simple as that of the simplex winding, complete equalisation between the two sections of the winding, in addition to the discharge action, which gives even better commutation than the simplex winding. Many machines, which would previously have been built with simplex windings, now have duplex windings, thus enabling a better and more efficient design to be used.

An outstanding example of a machine with the British Thomson-Houston duplex discharge winding is illustrated in Fig. 11. These motors, of which nine have been built, are rated at 50/0 h.p., 3,000/0 r.p.m. Here, again, no sparking was visible up to 100 per cent. overload. Nine motors, rated at 71/4 h.p., 1,700/100 r.p.m., have been supplied for crane drives. For this duty it is important to have as low a moment of inertia as possible, because a considerable part of the power is required to accelerate and retard the motor armature itself. By using the new duplex discharge winding it was possible to reduce the stored energy of the rotor to about a half what it would otherwise have been. An interesting test was carried out on one of these motors. A pilot motor was arranged so as to raise and lower the speed so rapidly that the motor took a current of three times the normal value. This test was carried out repeatedly with only the least trace of visible sparking.

From the foregoing account of recent developments in connection with discharge or damping windings, it is evident that considerable progress has recently been made by The British Thomson-Houston Company, Limited, in the design of both Schrage types and stator-fed types of alternating-current commutator motors. These developments have enabled higher outputs and speeds to be obtained than were thought possible a few years ago. For motors of standard industrial ratings good commutation is inherently easier to obtain on a Schrage motor than on a stator-fed motor. Taking all factors into consideration the Schrage motor is inherently the best motor for ordinary industrial service. Where the supply is at 3,000 volts or higher, or where a separate regulator is preferable, or where the conditions of output and speed make it more favourable, a stator-fed type of motor is recommended by the firm. Further, where a discharge or damping winding is required in the armature winding, the simplex or duplex winding at the top of the slot (as illustrated in Figs. 3, 4 and 5) is superior to the embedded damping winding at the bottom of the slot, as shown in Figs. 6 and 7.

The windings described have been selected as having been already well tried, and are now giving valuable practical results. At the same time, much experimental work has been carried out with other arrangements of damping windings, some of which have proved to be of little value, while a number of other windings which show promise are still in the experimental stage. Sufficient success has already been achieved, however, to show that the introduction of auxiliary commutating windings constitutes a major development in the art of constructing alternating-current commutator machines.

CONFERENCE ON SPECTROSCOPY.—A ninth summer conference on Spectroscopy and its applications is to be held at the Massachusetts Institute of Technology from July 21 to 23.

EXPORT OF MINE AND WELL-DRILLING MACHINERY.—The Board of Trade has issued the Export of Goods (Control) (No. 23) Order, 1941 (S.R. & O., 1941, No. 883, price 1*d*.), which came into force on July 10. Under the terms of this Order, licences will be required to export mine and well-drilling machinery to all destinations and mining-drill bits to certain specified destinations.

NICKEL-MOLYBDENUM STEEL IN AMERICA.—According to figures issued by the American Iron and Steel Institute, steel consumers in the United States ordered a greater quantity of alloy steel No. 4615 during 1940 than of any other alloy steel produced in large quantities. Stainless and heat-resisting steels, tool steels and low-alloy steels, however, were not included in the calculations. Steel No. 4615 contains about 1·75 per cent. of nickel and 0·25 per cent. of molybdenum. It is produced in the open-hearth furnace and is used chiefly for bearings, certain gears and motor-car driving pinions.

ENGINEERS AND ARMY SERVICE.—We are informed that corporate members and student members of the Institution of Civil Engineers who are serving in the Army, but not in the Royal Engineers, and who desire to be transferred to that Corps—with a view to the consideration of their qualifications for commissions—should apply to their respective commanding officers for permission to transfer. It is understood that, in suitable cases, these applications will be acceded to. Certificates of membership of the Institution, for attachment to these applications, may be obtained on application to the Secretary of the Institution.

BRITISH STANDARD SPECIFICATION.

THE undermentioned specification has been issued by the British Standards Institution and copies are obtainable from the Publications Department of the Institution, 28, Victoria-street, London, S.W.1. The price is 2*s*. net, or 2*s*. 3*d*. including postage.

High-Voltage Insulators.—With a view to bringing the British Standard Specification for overhead power lines into alignment with the international standard published by the International Electrotechnical Commission, a revision was undertaken some time ago and the results of the work have now become available with the issue of the 1941 edition of Specification No. 137 by the British Standards Institution. In this publication, toughened-glass insulators are included as well as porcelain, and this is an advance on the I.E.C. specification, which is still applicable to porcelain only. There has been, however, sufficient experience in this country of the use of toughened-glass insulators to enable the specification to be established. The performance tests are, in general, common to porcelain and toughened glass, but certain tests are peculiar to each type. For example, a porosity test is prescribed for porcelain but not for glass and a toughening test is prescribed for glass but not for porcelain. Another new feature of the specification is the appendix dealing with ball and socket fittings for suspension insulators the dimensions of which have been standardised with a view to securing interchangeability. The appendix on the selection of insulators has been entirely re-written in the light of experience gained during the last few years.

BOOKS RECEIVED.

Marine Navigation. By LIEUT.-COMMANDER P. V. H. WEEMS. New York: D. Van Nostrand Company, Incorporated. London: Chapman and Hall, Limited. [Price 30*s*. net.]

Fourth Annual Proceedings of the Railway Fuel and Traveling Engineers' Association, Hotel Sherman, Chicago, Ill., October 22 to 25, 1940. Chicago, Ill., U.S.A.: The railway Fuel and Traveling Engineers' Association.

United States Department of Labor. Bureau of Labor Statistics. Serial No. 1248. *Union Wages and Hours in the Bakery Industry, June 1, 1940.* By F. S. MCELROY. Serial No. 1252. *Average Hourly Earnings in the Drug, Medicine and Toilet Preparations Industry.* By S. C. SUFRIN, assisted by D. L. HELM. Washington: Superintendent of Documents.

United States Coast and Geodetic Survey. Special Publication No. 226. *Control Leveling.* Washington: Superintendent of Documents. [Price 5 cents.]

United States War Department. Miscellaneous Series No. 1. 1940 edition. *Supplement to Port and Terminal Charges at United States Seaports.* Washington: Superintendent of Documents. [Price 10 cents.]

United States National Bureau of Standards. Building Materials and Structures. Report BMS 68. *Performance Test of Floor Coverings for Use in Low-Cost Housing.* Part 3. By P. A. SIGLER and E. A. KOERNER. Washington: Superintendent of Documents. [Price 15 cents.]

United States Coast and Geodetic Survey. Special Publication No. 224. *Triangulation in Arizona* (1927 *Datum*). Part I. *First- and Second-Order Triangulation in the South Central Part of the State.* By C. L. GARNER. Washington: Superintendent of Documents. [Price 40 cents.]

United States Coast and Geodetic Survey. Special Publication No. 225. *Manual of Reconnaissance for Triangulation.* By WILLIAM MUSSETTER. Washington: Superintendent of Documents. [Price 10 cents.]

Material Tables for Wire Bar and Drawn or Extruded Section. Compiled for Use by The Bristol Aeroplane Company, Limited. North-street, Weston-super-Mare, Somerset: Lawrence Brothers (Weston-super-Mare), Limited. [Price 12*s*. 6*d*.]

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism for the Year 1939-1940. Washington: Carnegie Institution of Washington.

The Ohio State University. The Engineering Experiment Station. Bulletin No. 108. *Acoustic Models of Radio Antennas.* By E. C. JORDAN. Columbus, Ohio, U.S.A.: The Engineering Experiment Station, The Ohio State University. [Price 60 cents.]

INSTITUTION OF CIVIL ENGINEERS.—Among the awards made for papers read and discussed before the Institution of Civil Engineers, during the 1940-41 session, is that of the Baker Gold Medal to Dr. Oscar Faber, O.B.E., for his paper, "Aesthetics of Engineering Structures," and of a Telford Premium to Mr. A. J. H. Clayton, for his paper "Road Traffic Calculations."

PERSONAL.

The London sales office of MESSRS. STURTEVANT ENGINEERING COMPANY, LIMITED, is now at Bush House, Aldwych, London, W.C.2 (Telephone TEMple Bar 1961), and the head office is at 25, Worcester-road, Sutton, Surrey (Telephone Vigilant 2275).

MR. A. H. HALL retired on July 4 from the position of Chief Superintendent, Royal Aircraft Establishment, Farnborough, and his successor is MR. W. S. FARREN, until recently Director of Technical Development, Ministry of Aircraft Production. Mr. Hall became Superintendent in 1928.

MR. JOHN BRASS has been appointed acting president and chairman of the Emergency Executive Committee of the Institution of Mining Engineers, pending the election, when circumstances permit, of a president in succession to the late MR. E. O. FORSTER BROWN. Mr. Brass is a past President of the Institution. MR. LAURENCE HOLLAND, honorary treasurer, has been appointed vice-chairman of the Emergency Executive Committee.

MESSRS. CROMPTON PARKINSON, LIMITED, Electra House, Victoria Embankment, London, W.C.2, inform us that a new London Crompton and Kye electric-lamp depot has now been established at Ferguson House, 124, City-road, London, E.C.1. (Telephone CLErkenwell 3234/5 and 6), to replace the former depot at Brixton.

MR. R. J. M. INGLIS, M.Inst.C.E., F.R.S.E., T.D., who, as stated on page 5, *ante*, succeeds MR. G. MILLS as divisional general manager, Scottish Area, London and North Eastern Railway, joined the Engineer's Department of the North British Railway in 1898 and became Engineer, Southern Area, L.N.E.R., in December, 1936.

PROFESSOR H. W. SWIFT, M.A., D.Sc., has been elected president of the Sheffield Section of the Junior Institution of Engineers for the ensuing year.

PROFESSOR R. W. WOOD, research professor of experimental physics at Johns Hopkins University, Baltimore, U.S.A., has been awarded the Henry Draper Medal of the United States National Academy of Sciences.

MR. G. R. J. PARKINSON, M.I.E.E., for some years a director of the Midland Electric Corporation for Power Distribution Limited, Toll End-road, Tipton, Staffs., has recently been elected deputy chairman.

PROFESSOR FRANK HORTON, Sc.D., F.R.S., has been re-elected Vice-Chancellor of the University of London for the year 1941-42. He has been professor of physics in the University since 1914.

MR. CECIL WRIGHT, M.Sc., M.I.Struct.E., who has been chief assistant in the New Works Department, London and North Eastern Railway, since 1938, has now been appointed acting district engineer at Nottingham.

The arrangement whereby MESSRS. WILD-BARFIELD ELECTRIC FURNACES, LIMITED, are acting as distributors of the Spekker Steeloscope, manufactured by MESSRS. ADAM HILGER, LIMITED, has been extended. Messrs. Wild-Barfield have now been appointed sole distributors, in the United Kingdom, of the Spekker photo-electric absorptiometer, which is an instrument for conducting chemical analysis by colorimetric methods.

The registered offices of MESSRS. POWELL DUFFRYN ASSOCIATED COLLIERIES, LIMITED; MESSRS. THE POWELL DUFFRYN STEAM COAL COMPANY, LIMITED; and MESSRS. WELSH ASSOCIATED COLLIERIES, LIMITED, have been transferred from 1, Great Tower-street to 40, Lime-street, London, E.C.3. The telephone number, MANsion House 3270, is unchanged.

MESSRS. THE UNITED STEEL COMPANIES, LIMITED, inform us that MR. GERALD STEEL has been appointed assistant to SIR WALTER BENTON JONES, the chairman and managing director, in connection with the iron and steel works of the company, and that MR. C. F. WARD JONES has been appointed to a similar position in connection with the mines and mining ancillaries of the company.

ROYAL AERONAUTICAL SOCIETY.—At a recent Council Meeting of the Royal Aeronautical Society, Mr. Griffith Brewer, Hon. F.R.Ae.S., was elected president for the year October, 1941- September, 1942. Professor L. Bairstow, C.B.E., F.R.S., F.R.Ae.S., Mr. W. C. Devereux, F.R.Ae.S., and Lieut.-Col. the Rt. Hon. J. T. C. Moore-Brabazon, M.C., F.R.Ae.S., M.P., were elected vice-presidents for the same period.

ACQUISITION OF OMNIBUSES AND COACHES.—The Minister of War Transport has made an Order under which it is an offence, as from July 7, to acquire or dispose of a registered omnibus or coach without his authority. In future, any person, including a dealer, wishing to buy such a vehicle will have to make an application to a Regional Transport Commissioner for the necessary authority. It is already necessary for persons other than dealers to have a licence to acquire a new or unregistered omnibus or coach.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—South Wales miners during the past week, in common with those in all other coalfields throughout the country, received an additional 4d. per shift in respect of adult workers and 2d. per shift in the case of youths. The increase came into effect automatically under the sliding-scale agreement reached in the early months of the war by which miners' wages were regulated by the variations in the cost of living index figure. Since the outbreak of the war due to the increase in the cost of living index, and including the present increase, miners wages have risen by 2*s.* 8*d.* per shift in the case of men and by 1*s.* 4*d.* in the case of youths and boys. This is equal to 16*s.* per full week for men and 8*s.* a week for boys. It has been announced that in order to provide the additional manpower required for the industry, six panels have been set up and will operate shortly to adjudicate the position of about 3,500 men in or near the coalfield who have been employed in coal-mining at some time. The panels will consist of representatives of the owners, the men and officials of the Ministries of Labour and of Agriculture and will classify the men as suitable either for mining or land work. The steam-coal market continues to display considerable activity. The demand from both home and foreign customers is still good but new business was severely checked by the difficulty experienced by sellers in arranging stems. The tone in all sections was without any material change. Best large coals were moving off steadily but stems for the sized kinds were difficult to secure for some time ahead. The bituminous small sorts were also scarce and commanded good prices. Dry steam smalls, however, continued to be offered in excess of requirements and were dull. Cokes and patent fuel remained unchanged.

The Iron and Steel Trade.—The activities in the iron and steel and allied trades of South Wales and Monmouthshire remained at recent high levels. The demand for the various finished products was maintained and most works were kept engaged almost to full capacity.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Factories which have been greatly extended since the beginning of the war, and are employing women to an increasing extent, are producing record outputs of all types of tools. As, however, the demand continues to expand the productive capacity is being enlarged. Sheffield's output of tools materially exceeds the peak reached during the previous war. Among the lines in strong demand are milling cutters, reamers, twist drills, metal-cutting saws, hacksaws, screwing tackle, files, rasps, lathe tools, high-speed steel turning and planing tools, cold chisels, jigsaw blades, and all types of carbide-tipped tools and carbide tips. Among the specialised progressive lines are shell reamers and shell drills, and reamers used by boilermakers, bridgebuilders, shipyard operatives, and those engaged on plate work. The medium branches continue to be actively employed. The demand for farm and garden implements has been well-maintained, and firms specialising in the production of all types of agricultural machinery and machine parts are particularly busy. There is an increasing demand for electrical plant. Sheffield works are turning out large quantities of steel and parts for generators, transformers, switchgear and electric motors. High-pressure vessels and boiler drums are also in request. The special-steel making branches are actively employed, stainless and rustless materials, in particular, finding a ready market. Manganese steel is also a strong line. This material is being used extensively in the production of pulveriser hammers for crushing hard materials such as slag, stone, and hard rock. The heavy machinery and engineering trades are working at high pressure, and outputs of all types of raw and semi-finished materials have been fully maintained. The scrap position is quite satisfactory.

South Yorkshire Coal Trade.—Though the house coal market is suffering from seasonal influences, merchants are handling numerous orders. Heavy tonnages of industrial coal are being dispatched from the pits in this area; steams, slacks, smalls, and locomotive coal are all in strong demand. Coke makers are busily employed, business being brisk in foundry and furnace sorts. The export position shows no change.

THE INSTITUTE OF TRANSPORT.—As no further nominations were received to fill the vacancies arising on the Council of the Institute of Transport on September 30, the President has declared Messrs. R. Davidson, J. Elliot, W. C. Leslie-Carter, F. Lydall, J. B. Osler, O.B.E., P. R. Privett, E. W. Rostern, M.C., C. H. Sutherland, H. E. O. Wheeler and H. W. Elliott to have been duly elected as ordinary members of the Council as from October 1.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—As the stocks of several iron and steel commodities have reached a satisfactory level, the temporary curtailment of imports of these commodities from the United States and the Dominions is considered to be justified. Although the distribution of tonnage is adequate for most of the needs of the war industries, ordinary buyers still find some difficulty in obtaining parcels of material for general industrial requirements. The congestion of orders at the North East coast works has been greatly reduced, but the pressure for larger deliveries of one or two descriptions of material is still maintained.

Cleveland Iron Trade.—Increasing activity at iron foundries necessitates appreciably larger deliveries of pig, notwithstanding the extensive use of scrap. Cleveland brands of pig are scarce and there is little likelihood of an early increase in the meagre output, but supplies from other foundry-iron producing areas are sufficient for the growing demand. The fixed prices of Cleveland pig are based on No. 3 description at 128*s.* 6*d.*, delivered to Tees-side buyers.

Basic Iron.—The recognised market value of basic iron remains at 120*s.* 6*d.*, but in the absence of saleable parcels the quotation is nominal. Production is being maintained at a level which amply covers the requirements of the makers' own steelworks.

Hematite.—The shortage of hematite continues to necessitate the rationing of customers and strict economy in use, but the demand is gradually decreasing owing to the substitution of foundry and refined iron wherever possible and to the increasing imports of overseas commodities made from hematite. There seems to be little prospect of the expansion in the local output. The stabilised quotations of hematite are ruled by No. 1 description at 138*s.* 6*d.*, delivered to North of England areas.

Foreign Ore.—The arrivals of regular cargoes of ore from abroad are sufficient to supply current needs, except for hematite-making, now that so much native ironstone is being used instead of material from overseas.

Blast-Furnace Coke.—Conditions continue to confine transactions in Durham blast-furnace coke within narrow limits. The supply is plentiful and the consumption heavy, but holders are well sold and are disinclined to take new orders, while local users are as extensively bought as they consider advisable. The official quotations are ruled by good medium qualities at 36*s.* 9*d.*

Manufactured Iron and Steel.—A satisfactory tonnage of semi-finished iron and steel is stored at the re-rolling mills, all of which are busily employed. The producers of finished commodities have a good deal of work to execute and have numerous inquiries. Considerable sales of steel have been made. All shipbuilding material is in heavy demand and specifications for plates, angles, etc. continue to receive priority attention. The supply of special alloy steels is only just sufficient to meet present requirements. Structural steel is in considerable request and the available railway material is promptly taken up.

Scrap.—Merchants are delivering exceptionally large quantities of iron and steel scrap, which, however, are hardly sufficient to meet the present demands of users. Heavy grades of material are most needed.

WAGE-CALCULATING SLIDE-RULE.—Though wages can be calculated by the ordinary slide rule, a certain facility of manipulation and care in reading is required. Messrs. Omaro (England), Limited, 104, High Holborn, London, W.C.1, have, however, recently developed a form of rule which at one setting provides the answer in plain figures, without calculation, for any rate within its scope. The rule consists of a flat cardboard case with windows in both sides and an internal slide, also of cardboard, printed with a total of 2,350 values. One side of the case has a window at which the selected rate per hour is made to appear by movement of the slide, the amount due for periods of from ¼ hour to a full week of 47 hours appearing at other windows on the same side and on the opposite one. Besides the fractions ¼ hour and ½ hour there are 55 other readings for each hourly rate, the excess of these over the difference between 1 and 47, being accounted for by fractional periods, such as, 8¼ hours, 38¼ hours, etc. The hourly rates advance in steps of 1*d.* from 6*d.* to 2*s.* 6*d.* The front side is also arranged for readings for overtime up to 12 hours, readings for time-and-a-quarter, and time-and-a-half rates being available. Within the limits provided, which are suitable for the engineering and allied industries, any result can be accurately obtained in approximately one second. The makers of the slide rule suggest that by its use the number of persons now engaged on wage calculations can be considerably reduced, the surplus thus resulting being available for other duties.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF CIVIL ENGINEERS.—*Yorkshire Association:* Saturday, July 12, 2.30 p.m., The Hotel Metropole, King-street, Leeds. Ordinary Meeting. "The Lennox Road Refuse-Disposal Station," by Mr. W. S. Cameron. (To be preceded by a luncheon at 1 p.m.)

INSTITUTION OF THE RUBBER INDUSTRY.—*London Section:* Monday, July 14, 7.30 p.m., The Chemical Society's Rooms, Burlington House, Piccadilly, W.1. "New Viewpoints on (i) Rubber Preparation; (ii) Compounding; (iii) Anti-Oxidants; and (iv) Accelerators," by Mr. M. M. Heywood.

IRON AND STEEL INSTITUTE.—Saturday, July 19, 3.30 p.m., The Station Hotel, Dudley. Joint Meeting with THE STAFFORDSHIRE IRON AND STEEL INSTITUTE. (i) "Non-Metallic Inclusions in Steel: Quantitative Evaluation.—Part I," by Dr. W. H. Hatfield and Mr. G. W. Giles. (ii) N.P.L. Report "Intercrystalline Cracking in Boiler Plates," to be presented by Dr. C. H. Desch. (To be preceded by a luncheon at 1 p.m.)

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—The Scottish steel works are kept very busy in meeting the demands for deliveries for war material, and steel for ordinary purposes has been cut down to the minimum. There has been no falling-off in the demands from shipbuilders, and deliveries to the yards are being well maintained. Boilermakers are also very busy. Makers of black steel sheets still have well-filled order books but are managing to overtake arrears, and delivery times for new business have been reduced. Although the possibility of prices being advanced has been considered, the new quarter has commenced without any official intimation of a change. The following are still the current quotations:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable-Iron Trade.—There is still a steady demand in the West of Scotland malleable-iron trade and a satisfactory output is being maintained. Specifications from rivet, bolt and nut makers are coming to hand freely. There has been no change in the conditions at the works of the re-rollers of steel bars, and although the orders on hand represent a considerable tonnage the output has recently been so satisfactory that prompt delivery of certain lines can now be given. The stocks of semies held are ample to meet all requirements. The current quotations are as follow:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—No change has to be recorded in the state of the Scottish pig-iron trade, and output is being maintained at recent high levels. The demands of consumers are still heavy. Foundry grades of iron are moving rather slowly. The following are the present market prices:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steelworks; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

AUSTRALIAN INSTITUTE OF REFRIGERATION.—Negotiations for the formation of the Australian Institute of Refrigeration were concluded at a federal conference held recently at Albury. The co-operating bodies were the Society of Refrigerating Engineers and the Institute of Refrigerating Engineers, both of New South Wales, and the Victorian Institute of Refrigeration. Mr. E. R. Gordon, of Victoria, was elected President. The combined membership of the new Institute is upwards of 400.

TRANSPORT ADVISORY COUNCILS.—As a consequence of the merging of the Ministries of Transport and Shipping, the name of the Ministry of Shipping Advisory Council has been changed to the Shipping Advisory Council and that of the Ministry of Transport War Transport Council to the Inland Transport War Council. Sir Ronald Matthews, the Chairman of the London and North Eastern Railway, has succeeded the late Lord Stamp on the Inland Transport War Council and Mr. Robert Kelso, Chairman of the General Steam Navigation Company, has been appointed a member of this Council on account of his special knowledge regarding coastwise shipping. Coastwise shipping is represented on the Shipping Advisory Council by Sir Alfred Read, J.P.

COMMUTATING WINDINGS FOR ALTERNATING-CURRENT MACHINES.

MESSRS. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, RUGBY.

(*For Description see page 26.*)

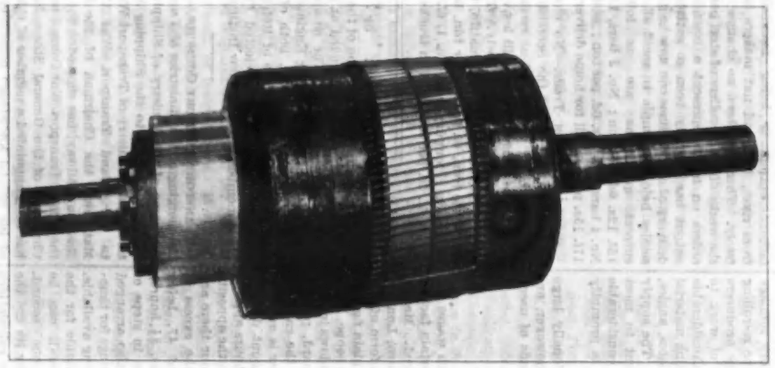


FIG. 8. ROTOR OF STATOR-FED COMMUTATOR MOTOR.

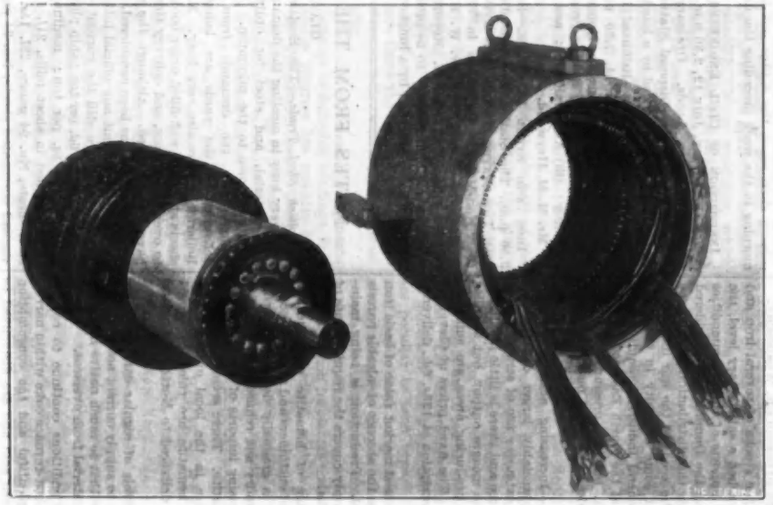


FIG. 9. ROTOR AND STATOR OF STATOR-FED MOTOR.

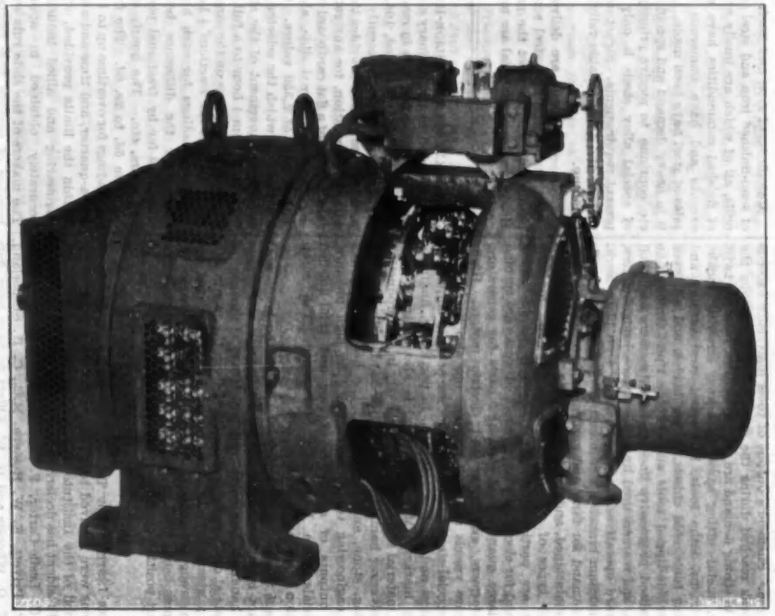


FIG. 10. MOTOR WITH ROBINSON DISCHARGE WINDING.

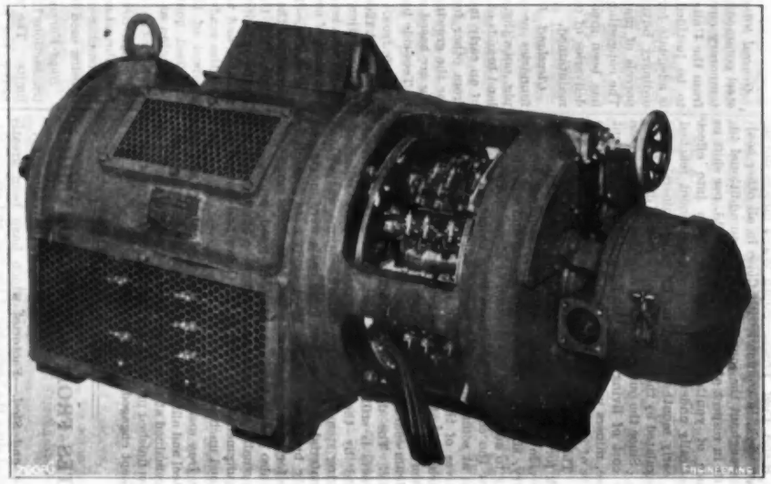


FIG. 11. MOTOR WITH DUPLEX DISCHARGE WINDING.

ENGINEERING.

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TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The Proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

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TEMPORARY ADDRESS.

For the duration of hostilities, the Editorial and Publishing business of this Journal is being conducted from 18 and 20, Compton Road, Hayes, Middlesex. The Telephone Number of the Editorial Department is Hayes 1730, and that of the Publishing Department, Hayes 1723. The Bedford Street Offices are open on Fridays only, between 10 a.m. and 5 p.m., for the distribution of the current issue and for retail sales.

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ENGINEERING

FRIDAY, JULY 11, 1941.

VOL. 152. No. 3939.

COMPULSORY POWERS.

IN time of war it is only natural that exceptional powers should be conferred on the national Government to take action in respect of private and public interests which, under normal conditions, would be permitted only after full examination of the circumstances and with some promise of due compensation; but, in the conferment of these powers there is usually some implied duty to establish the need for their exercise, and to refrain from making use of them for purposes not directly essential to the national welfare. As the experiences of the last war showed, however, and those of the present war are confirming, the appetite for this form of legislation comes increasingly with eating, and Government departmental heads develop a great reluctance to abandon the simple method of overriding opposition to schemes which they realise are reasonably certain to excite it. Where there is likelihood of an opposition that is merely frivolous, or deliberately obstructionary, or inspired by motives of personal and clearly selfish gain, it is right that there should be some lawful means of rendering it ineffective; but it is manifestly wrong that any official or body of officials should be given authority to assume in advance that opposition will be unjustifiable, and to brush it aside by a mere declaration that it cannot be entertained.

During recent weeks there have been two schemes under discussion, of very different characters, which have brought into considerable prominence this question of the right of appointed authorities to overrule objections, properly presented, and, on the face of things, sufficiently substantiated. One of them, that of the Grampian Power Company for the provision of additional hydro-electric plant capacity in Glen Affric, is definitely an engineering project. The other, relating to the construction of a new police station at Torquay, is of a type of local development with which, normally, this journal would not be concerned; it is cited now merely as an illustration of the apparent inadequacy of present safeguards against the questionable use of compulsory powers. There is no suggestion that either of these projects is fundamentally undesirable, apart from the inevitable outcry, in connection with the Glen Affric scheme, that is raised when any proposal is made to "desecrate" by the introduction of productive plant some stretch of country which few are likely to visit and fewer to dwell in; but it does not seem to us, in either instance, that a sufficient case has been made out for immediate action at all costs, in the face of protests that appear to be reasonable in character, and widely supported by persons whose motives are indubitably honest.

The question of the police station, apparently must be regarded as settled, for work has already begun on it. The case of the Glen Affric power scheme is under consideration by the House of Commons, where there is every indication that it will be very fully debated. If the Bill is refused a second reading, as is thought in some quarters to be a possibility, the reason will certainly not be any reluctance to encourage hydro-electric development in Scotland, but merely to affirm the general principle that, in affairs of this kind, there is an established procedure which should be followed unless there are better reasons for departing from it than have yet been urged. The merits of the scheme itself, as a means of providing additional power, are obvious, and the "anti-desecration party" should find their fears sufficiently guarded against by the special provisions for the preservation of the amenities of the district. In country where every glen has some peculiar and individual charm, it is impossible to undertake development of any kind without wounding some susceptibilities, but there are countless examples to prove that development need not be injurious in this respect. The real question at issue is rather one of principle, and the years after the war promise such a crop of similar disputations that it is as well that the principle should be clarified and upheld.

Some indication of what may be expected is to be found in the report in which the Civil Defence and General Purposes Committee of the London County Council presented, on July 1, the draft of the evidence proposed to be submitted to the Expert Committee on Compensation and Betterment, appointed on January 29 by Lord Reith, the Minister of Works and Buildings. The Expert Committee, under the chairmanship of Mr. Justice Uthwatt, were charged with the task of making "an objective analysis of the subject of the payment of compensation and recovery of betterment in respect of public control of the use of land," and were asked, *inter alia*, "to consider (*a*) possible means of stabilising the value of land required for development or redevelopment, and (*b*) any extension or modification of powers to enable such land to be acquired by the public on an equitable basis." One of the first steps taken by the Uthwatt Committee was to invite the views of the London County Council, as a body which would be necessarily concerned to an exceptional degree with the bearing of such questions upon post-war reconstruction. The matter was referred by the Council to the Civil Defence and General Purposes Committee, who, after consultation with the Town Planning and Finance Committees, drew up a suggested statement of evidence for submission to the Uthwatt Committee on behalf of the Council. We understand that the report containing the statement was adopted by the Council and has been presented to the Uthwatt Committee.

The powers of compulsory acquisition which the London County Council regard as necessary preliminaries to the work of reconstruction do not err on the side of modesty; and, even in the prefatory remarks of the statement, a bold attempt is made to establish a principle which, apparently, would affect all local authorities, irrespective of whether their areas had suffered war damage or not. The advisory "should" is conspicuous mainly by its absence; the minatory "must" occurs with a frequency that almost inhibits discussion at the outset. The statement is too long to be reported in full, but some attempt may be made to give the gist of the proposals.

"In any adequate approach to the problems with which the Expert Committee are concerned," the statement premises, "two dominant considerations must be borne in mind; first, that in the early post-war period the major tasks of physical reconstruction will coincide in point of time with (*a*) a

vast miscellaneous mass of major and minor works of repair and replacement, both public and private, and (*b*) the resumption of those social services such as housing, the provision and improvement of schools, hospitals, etc., which the war has interrupted. Secondly, that economic and social needs, as well as public opinion, will demand an energetic and decisive handling of the problems which will arise and the reasonably quick initiation and prosecution of the work which their solution will involve.

"The existing powers of local authorities must be extended if they are to avoid relapsing into the acceptance of what was, instead of achieving what should be. As regards the discharge by local authorities of their duties to provide social services, wider powers and speedier machinery of action must be conferred on them: as regards their duties as planning authorities, not only must the existing powers to control be enlarged and the liability to pay compensation modified, so as to be equitable to all interests concerned, but the authorities must be given powers which will permit them to make positive contribution to the reconstruction of the cities and areas for which they are responsible. If redevelopment on any acceptable basis is to be achieved, then town-planning must cease to be a merely regulatory process; it must be also creative. Where necessary, local authorities should have powers themselves to develop, and not be limited to the regulation and guidance of development by others."

That exceptional powers will be necessary in order to avoid excessive delay in reconstruction work is perfectly clear; there will be delay enough, unavoidably, because of the sheer magnitude of the task involved. It is a simple matter to draw straight lines on a street plan to indicate where some new thoroughfare is to replace a tangle of narrow streets; but no one who has not encountered the problem can realise the extraordinary complexity of the drains, mains, cables, etc., which accumulate in the course of years beneath any city street, or the amount of planning that is involved in making alterations to the layout without interrupting the services affected. It is natural, therefore, that public bodies should desire to save as much time as possible on the preliminary steps of establishing the case for an improvement, obtaining the authority to proceed, and dealing with the various sectional interests involved. A perusal of the clauses in the L.C.C. committee's statement shows that they are fully alive to the difficulties that may be met. The urgency of the reconstruction work must be admitted, together with the excellence of the motives which have actuated those responsible for public improvements in the past, and, no doubt, inspire their successors to-day; but we question the advisability of giving any public authority, however constituted, a virtual *carte blanche* to do as it likes.

Under paragraph 10 of the statement, the Committee (and now, the Council, as it has adopted the report), urge that powers should be conferred to acquire properties compulsorily, without having previously determined whether they will be needed or not, and "free from the formalities which now retard the grant and exercise of compulsory powers." The paragraph continues, "A mode of acquisition which dispenses with the need for detailed schemes in advance, and with much of the delay involved in the present procedure, is undoubtedly desirable. These improved powers should not be restricted to any particular purposes; for reconstruction involves all branches of public activity, and the powers should accordingly be conferred for all statutory purposes, including those to be conferred in connection with reconstruction *and should be exercisable both within and without the area of the local authority using them.* It is not anticipated, however, that more than a limited use could be made of the powers during the course of the war."

The italics are our own, and might have been employed, perhaps, for some of the earlier passages as well. The sponsors of these proposals may be actuated by the most unexceptionable motives, but we have no hesitation in expressing the opinion that it would be unwise to confer such far-reaching powers on any local authority without better safeguards than appear to exist at present.

FIRE RISKS IN RAILWAY TRAINS.

IT is most unfortunate that, in the interests of economy, the reports of inquiries into the causes of railway accidents are no longer being published and circulated in the usual manner. We believe that both Germany and Italy would be impressed to read how, in the middle of a war in which, according to enemy propagandists, the British people have been already reduced to dire straits by air attacks and by blockade, and their cities ravaged by fire, an official of the Ministry of War Transport could proceed calmly to test whether, and how, a railway passenger coach could be set alight by a dropped match. The slogan of "business as usual," like most slogans, can be overdone; but there is something better than the reiteration of a parrot-cry in this unperturbed investigation, with its implied conviction that, in due course, the temporary inconvenience of war will pass, and life will resume once again its normal channels.

The report which Colonel A. C. Trench has presented to the Minister of War Transport on the fire which destroyed three coaches of an express train on the London and North Eastern Railway on April 28, should not unduly disturb the public faith in the general safety of railway travel, while it may have a salutary effect by encouraging a little more thoughtfulness and elementary care on the part of passengers, some of whom can take little credit for the fact that the number of fires occurring in passenger trains is not considerably greater. In this instance, it will be recalled, six schoolboys lost their lives and seven others were injured, although it does not appear that more than ten minutes can have elapsed between the discovery of the fire and the stoppage of the train.

The circumstances, briefly summarised, were as follows. The train was the second portion of the 12.45 p.m. express from King's Cross to Newcastle and consisted of eleven bogie coaches with Pullman vestibules, and connected by Buckeye couplings. It was drawn by a 2-6-0 locomotive of the V2 class, and was fitted with the vacuum brake and lighted throughout by electricity. The last three coaches comprised two open vestibule thirds and a brake van, reserved for about 100 boys who were returning to Ampleforth College in charge of a master. The guard, however, did not occupy this brake van, but was in another van, ahead of the reserved coaches, which were to have been detached at York. The train had stopped at Grantham, where the guard walked down the platform past the reserved coaches without noticing anything unusual. Soon after leaving Grantham, however, the communication cord was pulled in one of these coaches, and then in the other. The train was travelling at about 55 miles an hour, and was some seven miles north of Grantham. It was stopped in about a mile and a quarter, by which time the fire had taken a firm hold in the middle coach of the three. Attempts were made to uncouple the brake van, but these were abandoned when it was seen that the flames were spreading in the other direction; but before the first of the three could be disconnected from the burning coach, it became evident that it would have to be abandoned if the rest of the train was to be saved. This was done and the two coaches and the van were completely burned down to the underframes.

There was no lack of evidence at the inquiry and most of it seems to have been clear and definite. The boys were flicking lighted matches at each other and one match fell between the side of a seat and the side of the coach, where it was fanned by draughts caused by the motion of the train and caused a fierce local fire in the inverted Vee-shaped space between the backs of adjacent seats. Soon afterwards the flames burst into the central gangway and spread up the sides and along the roof. The seats were of the open bucket type, arranged in groups of four on each side of the gangway, and were constructed on a wooden framing mounted on metal pedestals. The seats and back cushions were sprung and padded with horsehair pleated with wadding. The roll edge round the back and sides was filled with sponge rubber and the cushions were covered with moquette, except on the front and the roll edge, which were leather-covered. The backs and underside were covered with plywood, and on the backs there was also a thin layer of wadding and an outer covering of Rexine. A circumstance of some importance, as it transpired, was that the gangway door between the first of the reserved coaches and the van in which the guard travelled was locked, in accordance with regulations, with the result that the fire extinguisher in that van was not immediately available. The gangway door into the trailing van was also locked, but, as Colonel Trench observes, this appeared to have no material bearing on the casualties; and, he added, it was doubtful if the extinguisher in the guard's van would have been of real use in dealing with a fire which was spreading rapidly in a strong draught.

Colonel Trench drew attention to three points in formulating his conclusions. One was the practice of locking gangway doors, mentioned above. The others were the time taken to stop the train after the communication cord was pulled, and the fire risk of the equipment of the coach. When the cord was pulled for the first time, the driver and fireman looked back along the train, but as they saw nothing obviously wrong the driver considered running on to the Westborough signal box, about 1,000 yards ahead, so as to have access to a telephone if necessary. At this stage the cord was pulled in the other coach, and, therefore, he made a full brake application which stopped the train about 490 yards short of the box. It does not appear that his brief hesitation affected the issue, but Colonel Trench remarked, the instruction is definite that, when a driver observes that the brake is being applied, he must infer that the cord has been pulled and must stop the train as quickly as possible. He thinks it desirable to emphasise, therefore, that "running on to the signal box for the sake of proximity to a telephone . . . would not have been a justifiable exercise of a driver's discretion."

The locking of gangway doors is intended as a precaution against pilferage from unattended vans and possible tampering with brake equipment, as well as a barrier between first-class and third-class accommodation. The question is, therefore, "whether the real everyday arguments in favour of locked doors are counterbalanced by the comparatively few emergencies when open doors might be preferable." Colonel Trench comes to the conclusion that there is justification for locking doors of unoccupied brake vans, wherever they may be situated in the train, but that the locking of gangway and corridor doors is open to question and, in composite coaches with a door halfway down the coach, is definitely undesirable.

The fire risk inherent in the type of seat construction employed he regards as no greater than with any ordinary type of seating, but he suggests that the wadding and the outer Rexine covering on the backs of the seats might be omitted. This conclusion was reached after numerous experiments, which indicated that uncovered plywood was more fire-resistant than the Rexine-covered seat backs. The Rexine was not highly inflammable in itself, but a strong draught between the seat backs, which form a natural flue, might accelerate combustion appreciably. It is evident from his summing-up, however, that the main lessons of this fire require to be studied by the travelling public in general rather than by the railway companies or their employees. The carelessness habitually displayed by many passengers in the disposal of matches and cigarette ends is quite inexcusable and might well be made the occasion for more pointed comment by the companies than it has received hitherto. It would be interesting to know, for example, what quantity of cigarette ends is being carried at any given time inside the door frames of suburban compartment coaches fitted with drop windows. On the other hand, the railways themselves might discourage such practices more than they do by fitting larger and more substantial ash trays, not so easily filled or damaged as those commonly employed. The greater prevalence of smoking, compared with even ten years ago, justifies better provision in this respect, possibly on the lines of the heavy brass boxes fitted inside the doors on the Mitropa and other Continental rolling stock.

NOTES.

SCIENTIFIC AND INDUSTRIAL RESEARCH IN AUSTRALIA.

THE complications of war-time transport, superimposed upon Government-office routine which has been probably disorganised to a considerable extent by all the abnormal demands inseparable from "war effort," are causing some of the customary annual reports from the Southern Hemisphere to be practically a year old by the time that they reach this country. A case in point is the 14th Annual Report of the Australian Council for Scientific and Industrial Research, which arrived just too late to be reviewed in the previous volume of ENGINEERING. It covers the twelve months ended June 30, 1940, was presented to the Commonwealth Parliament on December 5, and ordered to be printed, December 13, 1940. It may be presumed, therefore, that some of the work described as being in hand is actually past history, since the year to be covered by the 15th Report has now elapsed. Nevertheless, the 14th Report is of much interest as indicating how the normal work of the Council is being steadily pursued, concurrently with much special research directly inspired by war conditions. These special studies, undertaken to meet war requirements, have been principally directed to the expansion of Australian production of commodities which could no longer be imported, the utilisation of products of which there was a surplus in consequence of the restriction of certain exports, and the use of Australian materials in the development of new industries. Important items in this programme were investigations of the suitability of Australian timbers for use in aircraft construction, and of the problems of flax cultivation. Before the war Australia, like the United Kingdom, depended largely upon imports from Europe for the supplies of flax required for cordage and the manufacture of tarpaulins. The area experimentally planted with flax in Australia was not large, but it was to be increased to 21,000 acres and promised well for future developments. Other important work of the Forest Products Division of the Council concerned the production of paper pulp. The report notes that, as a result, three large industries have been established, manufacturing, respectively, writing papers, newsprint, and wrapping papers. The Division of Food Preservation and Transport, it is stated, has been working on the drying of various foodstuffs with a view to their export in that condition, which would enable a considerable saving of shipping space to be effected. The building which is to house the Australian National Standards Laboratory has been completed. It stands in the grounds of the University of Sydney and, when the report was prepared, was in process of equipment. Nine senior officers of the Laboratory were sent to England to study the apparatus and methods at the National Physical Laboratory, and it was expected that the organisation would be of material assistance to the Australian munitions industry, in particular in the production and checking of gauges. The Division of Aeronautics also moved into a new building during the year under review. This is situated at Fishermen's Bend, Victoria, and, like the Standards Laboratory, was awaiting the arrival of some of its equipment and the completion of the large wind tunnel for aerodynamical work. Plans for a laboratory for the newly-formed Division of Industrial Chemistry have been completed, and it was expected to be erected some time during 1941. The nucleus of a staff was appointed in 1940 and was being temporarily accommodated in existing laboratories. The initial programme for the Division's work included researches on industrial minerals, wool, leather and dairy products. Irrigation problems have continued to be studied at the Commonwealth Research Station at Merbein, Victoria, in the Mildura fruit-growing district, and at the station at Griffith, New South Wales, in the Murrumbidgee irrigation areas, where the floods of 1939 caused extensive damage to fruit orchards. In the section of the report devoted to the Fisheries Division, it is stated that the rapid growth of the salmon-canning industry, and its by-product meal and oil industries, has led the Division to provide an advisory and analytical service, including experimental work on the methods of liver preservation and oil extraction. The total expenditure of the Council for Scientific and Industrial Research during the financial year 1939–40 amounted to 304,933*l.*, of which 74,030*l.* was contributed from sources other than the Commonwealth Treasury.

THE ESSENTIAL WORK (BUILDING AND CIVIL ENGINEERING) ORDER, 1941.

Particulars have now been issued by the Ministry of Works and Buildings of the arrangements made to bring certain building and civil engineering work under the operation of the Essential Work Order applicable to them. On these contracts, early completion is highly important in the national interest, and it was decided, therefore, to introduce a system of payment by results. The necessary negotiations are in progress, but the urgency of the position does not permit of a postponement of the scheme until these are completed, and the Government have decided to bring the system into operation provisionally without further delay. The method to be adopted is to pay a bonus, additional to ordinary time rates, for all work over and above a fixed hourly output. Though calculated on an hourly basis, it will be ascertained weekly, and, normally, by gangs. It is to apply, in the first place, to hand and mechanical excavating, stone hard-core and brickwork, and concreting, and will affect only such immediately urgent undertakings as are scheduled under the Essential Work Order. In ascertaining the bonus, no attention will be paid to time lost for reasons beyond the operative's control, such as bad weather, lack of materials, or breakdown of machinery, but this time will be paid for at the customary hourly rate. The rates have been worked out only for certain classes of work, but it is intended that they shall serve as a basis on which to determine, on the site, the rates for other similar classes, to which the bonus system can be applied. They are intended to apply in "reasonably favourable" conditions, and upward adjustment is to be made on site if the existence of less favourable conditions requires it. An assurance is given that, if the representatives of the employers and the men who are engaged in the present negotiations should agree on any adaptation of the proposals which may promise to be more effective, the Government will adopt the modification; but, meanwhile, unauthorised departures from the scheme will not be recognised. It is stated, also, that, as the adoption of the scheme constitutes a "change of practice," it will operate only for the period of the war, unless continued by joint agreement; and that in no case will an employee receive less remuneration under the scheme than he would have done for the same time under existing agreements or under the "guaranteed pay" provisions of the Essential Work Order.

WOMEN ON ENGINEERING WORK.

Evidence is steadily accumulating that the early difficulties and delays that accompanied the introduction of women into engineering workshops are being overcome, and that increasing numbers are completing their training and becoming valuable units in the national labour force. On a former occasion we have recorded some of the operations that were being undertaken successfully by women, many of whom had progressed to positions of some independent responsibility. A statement recently issued by the Ministry of Labour and National Service provides further instances of the employment of women on engineering production of heavy as well as light types. The cases cited cover 21 firms, engaged on work of very varied character, and include a fair number of machining operations for many of which the women do their own setting. The circulated statement bears indications, however, that it has been prepared primarily for non-technical consumption and there is more than a suggestion, in the phrasing of it, that the compiler was not personally familiar with many of the operations described; otherwise, it may be supposed, less emphasis would have been laid on processes in which, quite obviously, the high degree of accuracy attained owes comparatively little to the innate aptitude or the acquired skill of the operator. Nevertheless, when all allowances of this kind have been made, and any excess of propagandist enthusiasm has been discounted, there remains more than sufficient evidence to show that many of the women whose war work is engineering manufacture are achieving a very creditable standard of proficiency in operations which must have been entrusted to them, at the outset, with a certain amount of misgiving. The first instance cited is a firm manufacturing steel drums; 90 per cent. of the production is now carried on by women, whose numbers have risen to over 500. All the training is done by the firm, who are now proposing to engage a further 800 women. In another works, women are employed in milling turbine blades—not exceptionally difficult work with modern machines, though we do not recall that it was regarded as suitable for women to undertake during the last war; but one woman is engaged on the actual blading of rotors, which is certainly unusual. The fitting and assembly of carburettors and their controls, for aircraft engines, is definitely work that calls for applied intelligence. The various stages in the production of radial-vane fuel pumps for aircraft also demands a somewhat high standard, especially when the operative is responsible also for setting-up. These are but a few examples from a long list which may be regarded as a satisfactory interim report on the absorption of women into engineering industry.

ORGANISATION OF WAR PRODUCTION.

AN important announcement regarding the organisation of production was made by Mr. Bevin in the House of Commons on July 8. He stated that it had been decided to set up a Central Joint Advisory Committee to the Production Executive and that it would be composed of 12 employers' representatives, nominated by the British Employers' Confederation and the Federation of British Industries, and 12 workpeople's representatives nominated by the Trades Union Congress. The terms of reference of the new committee were "To advise the Production Executive on general production difficulties (excluding questions relating to wages and conditions in individual industries normally subject to joint negotiation) and on such other matters relating to production as may arise from the proceedings of Regional Boards or be referred to the Committee by the Production Executive." The Production Executive had given careful consideration to the question of improving the effectiveness of the organisation of area boards and had decided upon certain changes which were designed to strengthen these boards as instruments for furthering the production of goods for war purposes in the areas which they covered. The boards, of which there was one for each Civil Defence region, had been re-named the Production Executive Regional Boards and, in future, they would be directly responsible to the Production Executive instead of being directed, as hitherto, by the Industrial Capacity Committee. The main function of the Boards was to utilise industrial capacity in their districts. In other words, this involved a process of decentralisation in the supervision of contracts and orders and in the real and effective utilisation of machine tools and all other equipment. Each Production Executive Regional Board would be composed of three representatives of employers and three of workpeople and the official members would be local representatives of the Admiralty, Board of Trade, Ministry of Aircraft Production, Ministry of Labour, Ministry of Supply, Ministry of Works and Buildings, the Regional Transport Commissioner and the chairman of the Machine-Tool Area Committee. The members of the Central Joint Advisory Committee were Lord Dudley Gordon, Messrs. H. F. Brand, J. S. Boyd, Lewis Jones, M.P., W. A. Lee, Guy Locock, G. S. Maginness, A. McKinstry, A. J. G. Smout, and Sir C. Bruce-Gardner, Sir A. Ramsay, Sir J. Walker-Smith and Sir J. Forbes-Watson, representing the employers, and Sir W. Citrine and Messrs. C. H. Bagnall, A. Conley, A. Deakin, C. Dukes, W. Elger, G. Gibson, F. Hancock, H. N. Harrison, M. Hodgson, J. Kaylor, P. Paterson, and G. W. Thomson and Miss F. Hancock, representing the workpeople.

LETTER TO THE EDITOR.

EDUCATION AFTER THE WAR.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read with great interest the article on "Education after the War" in your issue of June 13, and particularly the reference to the need for dividing trainees into grades. I am enclosing details of the Norwich Training Scheme, which refers to entrants into the Electricity Department of the Norwich Corporation. The scheme is designed to meet the special needs of entrants into the electricity supply and installation industry.

It will be seen that the scheme divides trainees into three grades, entrance to each grade being dependent upon a candidate's academic attainments. While the scheme permits any trainee to enter into another and higher grade if he subsequently attains the educational qualification, it recognises that only a minority of the trainees will ultimately enter the higher administrative or technical posts.

The estimated full complement of Ordinary Trainees is 38, of Section Trainees 12, and of Departmental Trainees, 4. All the Ordinary Trainees and some of the Section Trainees will pass out as qualified tradesmen at the age of 21, and I am interested to note that the estimated percentage for this scheme is about equal to the 64 per cent. referred to by Dr. A. P. M. Fleming. I have some doubts whether the establishment to a greater degree of the technical high schools referred to in the Spens report would decrease this percentage of artisans, which is fixed largely by the structure and demands of industry. It would appear to me that the effect of the extended technical school training would be to increase the competition for the higher administrative posts and to improve the standard of those remaining for the other posts.

Yours faithfully,
J. A. SUMNER,
City Electrical Engineer.

Corporation Electricity Offices, Norwich.
June 24, 1941.

[The description of the scheme, necessarily abridged, appears on page 36 of this issue.—ED., E.]

OBITUARY.

DR. JOSEPH WARD, J.P.

THE death of Dr. Joseph Ward, which occurred on July 7, at his home, Endcliffe Grange, Sheffield, after a serious illness, removes a well-known figure from among the Sheffield industrialists. Dr. Ward, who was chairman of Messrs. Thos. W. Ward, Limited, Albion Works, Savile-street, Sheffield, and had taken a leading part in the activities of the firm and in those of its associated concerns for upwards of 60 years, was born in 1864. As a boy of 14 he joined his elder brother, the late Mr. T. W. Ward, founder of the firm of coal, metal and machinery merchants which bears his name, in 1878. Dr. Ward was taken into partnership in 1889 and when the firm was incorporated as a limited company in 1904 was appointed joint managing director. He was made chairman of the company in 1919. He also took a leading part in the formation of the Ketton Portland Cement Company, Limited, of which he was chairman and managing director. In addition, he was chairman of Messrs. Ribblesdale Cement, Limited; Messrs. Thomas Smith and Sons (Rodley) Limited; The Midland Iron Company, Limited; Messrs. Marshall, Sons and Company (Successors), Limited; and of the subsidiary and associated companies of Messrs. Ward. During the war of 1914-18, he served as adviser on scrap iron and steel to the Ministry of Munitions. Dr. Ward was made a J.P. in 1922 and elected Master Cutler in 1931. As chairman of the Applied Science Department, he rendered valuable service to the University of Sheffield and in recognition of this the honorary degree of LL.D. was conferred on him in 1939. He was elected a member of the Iron and Steel Institute in 1912.

OCEAN AIR TRANSPORT.*

By J. T. TRIPPE.

(*Continued from page* 16.)

MY account of our transatlantic operations must seem so far to be largely a tale of difficulties. Yet, despite these early growing pains, and despite the severe difficulties imposed by the war (which, among other things, restricted the scope of the weather service on which much effort had been spent), we feel that, even in these two difficult years, some progress can be assumed in the developing art of ocean air transport. That our operating organisation has succeeded in maintaining a reasonable record of service, and to date an unblemished record for safety is, to all personnel, a source of real gratification. The methods developed to achieve this record represent our contributions to air transport. They are, to a large extent, original with Pan American Airways, and, to my knowledge, have never been previously discussed in detail. First came the development of the "Multiple Flight Crew," through whose specialised organisation and training it has been possible to conduct transport flights as long as 24 hours in duration. Second, the accessibility of power plants, a feature which Pan American has sponsored, and the practical results of which have made this a pre-requisite for future oceanic operation; and third, the development of a system of scientific flight control, through an individual ocean flight-plan, which directly applies the analysis of any given set of conditions, to the end that the flight shall be conducted on a basis of known quantities and towards deliberate elimination of all possible uncertainties.

The Multiple Flight Crew.—At the inception of our four-engined operation, we adopted as standard a four-man crew. This was adequate for Caribbean operations, but our analysis of ocean transport problems indicated the need for crews far larger and individually trained for specialised assignments. We considered the primary personnel requisites of ocean air transport to be: (1) expert direction of the flight; (2) piloting; (3) navigation; (4) control and care of power plants; (5) maintenance of communications; (6) passenger service. Thus evolved the concept of today's standard multiple flight crew, composed of a captain and his crew of ten. Directly responsible to him are five officers, qualified as specialists in the primary departments—piloting, navigation, engineering, communications, and passenger service. Each of these has a qualified assistant capable of relieving him for rest periods. The training of this composite group ensures its smooth and automatic functioning as a complete flight organisation. The crew of eleven is as highly organised as any which ever operated a destroyer or a submarine.

The captain is the chief administrative officer. He is invariably a veteran of many years of experience on Pan American's overland, as well as overseas, divisions. In addition he has qualified himself to attain the rank of Master of Ocean Flying Boats. This rank testifies that the individual has successfully demonstrated sound judgment throughout his professional career and is an expert in all phases of piloting. He is also qualified in aeronautical engineering, in engine and aeroplane mechanics, in meteorology, in radio operation. He holds the equivalent of a master mariner's ticket. His rank further testifies that he has qualified himself in the subjects of international law, marine law, and business administration as required for the performance of his duties. In trans-ocean operation, all of these special qualifications are at one time or another required of the captain of an ocean-going flying boat. It has been our experience that five years of training and post-graduate study are required to make a master ocean-flight captain out of an excellent pilot.

The captain is directly responsible at all times during the flight for the safety and well-being of the aircraft, of the persons and goods carried, for the conduct of his crew and for the completion of his mission in exact accordance with his orders. His station is the left-hand pilot seat during all take-offs or during approaches to airports, during landings and in all emergencies. An administrative station is provided for the captain at an "office" at the rear of the flight deck. During the course of the flight he personally supervises all crew members, makes periodic checks of the navigation and prescribes speed, track and altitude of the aircraft. The first officer is second in command, after the captain, and alternates with him as senior watch officer. His qualifications are also second only to those of the captain and he is usually a senior pilot, qualified for early advancement to a captain's rating. He is the executive officer of the ship. He is responsible for the proper loading and unloading of all cargo and for a thorough general inspection of the aircraft before take-off. His primary station is the right-hand pilot seat.

The second officer, who is a senior pilot-in-training, is responsible for the navigation of the aircraft. Our navigation technique can best be described as "as thorough as we can make it." The navigation means available to this officer are three: dead reckoning, celestial observations and radio bearings. Our dead-reckoning methods are basically similar to those used in deep-sea practice. For some years, however, we have been using a drift sight target which, I believe, is original. It consists simply of a small thin-walled glass flask, filled with pulverised aluminium powder. Breaking instantly upon impact with the water, it quickly produces a large and extremely visible "slick" to give a fixed point upon the water's surface. At night, magnesium flares are used for the same purpose. Our celestial navigation practices are as "streamlined" as we can devise to speed the translation of octant sights upon sun, moon or stars into actual position data. Normally, celestial "fixes" are made at least once an hour, and dead-reckoning positions are computed between such "fixes" at least every half hour. As a third method of checking the ship's position, the navigation officer makes constant use of radio bearings from direction-finder stations ashore taken on the plane or by bearings from the plane itself upon shore stations and ships at sea.

The flight engineer is responsible for the mechanical operation of the aircraft and the power plants. He is responsible for loading of fuel and oil in amounts specified by the captain, and personally measures the supply of each aboard before departure. He also participates in the inspection and servicing of the plane and familiarises himself with its recent mechanical history. During the flight his station is aft and at the starboard side of the flight deck. At this station, the engineer has before him his own control panel, composed of some 41 separate instruments, in addition to the engine throttles, carburettor settings, fuel-supply valves and other power-plant adjustments. The engineer's log, at the end of a typical transatlantic round trip, contains some 7,300 notations covering periodic reports on every phase of the ship's mechanical operations.

The flight radio officer is responsible for the operation of the plane's complete radio equipment and for maintenance of constant communication with the radio-control stations ashore. At a minimum, he must contact his watch-ground station every 15 minutes. On the half hour, he must transmit the ship's position, and on the hour, in addition to the position, a complete report on its navigation and progress, the track made good, winds, weather and general conditions. He constantly receives weather reports and bearings from ground stations and in turn himself takes radio bearings upon surface stations or upon any available ships within range.

Radio equipment carried by a Clipper consists of two completely interchangeable telegraph and telephone transmitters, which can operate on either high or low frequency, thereby providing for communication with surface vessels as well as with ground control stations. The ship also has two receivers, the functions of which are interchangeable, and which cover frequency bands of 200 kc. to 18,000 kc. There is also an automatic direction-finder which can be manually operated. An additional receiver for radio-telephone operation, controllable from the pilots' posts, is carried for use within 60 miles of terminal stations, in conjunction with the regular transmitters. For communications, ground control stations are equipped with from three to five transmitters of various power outputs, for ground-to-plane and point-to-point communications, together with the necessary receiving equipment. Each station, in addition, is usually equipped with radio navigation facilities. Normal communication ranges are in the neighbourhood of 3,600 miles.

The flight steward's duties include responsibility for all details related to the comfort of passengers, such as the serving of meals, the preparation of berths, and the handling of luggage aboard ship. With sometimes as many as 32 passengers to care for, in addition to the crew, he is not the least busy member of the ship's complement. The third officer, who is a junior pilot-in-training, serves primarily as relief for the second officer during flight. Prior to take-off, he assists the first officer in his inspection and has a duty of his own to make sure that all hatches and bulkhead doors are closed. Immediately, after take-off, he conducts a visual examination of major external structural components and reports his findings to the captain. He handles the bow mooring line when casting off and mooring. The fourth officer, also a junior pilot, assists the pilot officers in both flight and ground duties. The multiple flight crew is completed by an assistant flight engineer, an assistant flight radio officer, and an assistant flight steward, whose duties are obvious from their titles.

(*To be continued.*)

* 29th Wilbur Wright Memorial Lecture, delivered before the Royal Aeronautical Society, in London, on June 17, 1941. Abridged.

SURFACE QUALITY OF A MEDIUM-CARBON STEEL.*

By O. W. BOSTON and W. W. GILBERT.

THE machinability of a metal is rated in various ways, depending upon the particular item of greatest concern; tool life, power consumption, and surface finish are of greatest importance and yet they are not inter-related. The acceptability of a product is often determined by the quality of the surface finish. Several of the factors which influence surface finish, reported upon in this paper, are cutting speed, cutting fluids, and the heat-treatment of the material cut. In preliminary surface-finish tests made when turning a cylindrical bar, it was found that the cutting speed had a marked influence on the surface finish. Because of this, facing cuts were taken on the face of a disc, the cut starting at the edge of a ¼-in. diameter hole, with a radial feed towards the outside at a constant number of revolutions per minute. In this way, the cutting speed was increased constantly from a low speed near the centre of the disc to a maximum speed at the outside diameter. Thus, the complete range of speeds was obtained in one cut.

Since finishing cuts are usually small, a light depth of cut of 0·0035 in. was used. In order to observe the surface more readily, a heavy feed of $\frac{1}{16}$ in. per revolution was used to make it possible to photograph the surface and measure the imperfections. Some of the tests were made at very high speeds, and it was questioned whether the high cutting speed at the outside diameter would dull the cutting tool and produce a change in surface finish due to this dullness. To check this variation, the normal testing procedure was reversed and the facing cut was started on the outside diameter and the tool fed towards the centre of the disc. If the high speed did dull the tool, then the surface finish for low speeds would be changed. Several tests were made and it was observed that the surface finish was not changed by starting at the outside rather than at the inside and facing outwards.

Again, to check the effect of dulling, tests were made on a cylindrical bar of steel. First high and then low speeds were used alternately, and no variation due to tool wear could be detected unless the speeds were increased to a point high enough to damage the tool as determined by visual observation. A 12-speed geared-head engine lathe was used, having 14-in. swing and 32-in. centres, driven by a constant-speed 3-h.p. motor through multiple-Vee belts. The cutting tool used in these tests was a ½-in. square shank, tipped with tungsten-tantalum carbide (Firthite grade R). This tool was ground to have working angles of 6 deg. back rake, 6 deg. side rake, 6 deg. relief, 6 deg. side relief, 6 deg. end cutting-edge angle, 0 deg. side cutting-edge angle, and $\frac{1}{16}$ in. nose radius.

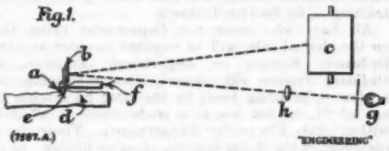
The steel cut had the chemical analysis given in Table I. It was received in a normalised and annealed condition, in the form of a forging 14 in. in diameter by 48 in. long, having an average Brinell hardness of 190. During the tool-life tests, the log was reduced to a diameter of 5 in. For the surface-finish tests, a number of discs each ½ in. thick were cut from the end of this log. The heat-treatment of these discs is given subsequently in this paper. The discs were faced at a wide range of speeds, with various cutting fluids, and for different structures, as outlined later.

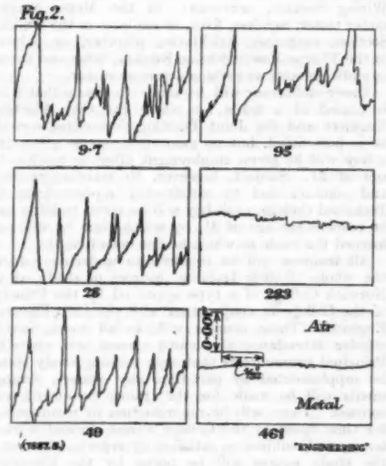
TABLE I. *Composition of S.A.E. 3140 Steel.*

Element.	Per cent.
Carbon	0·42
Manganese	0·69
Sulphur	0·021
Phosphorus	0·017
Silicon	0·17
Nickel	1·41
Chromium	0·61

Four cutting fluids used in these tests were applied at the rate of 1 gallon per minute from a ¼-in. diameter nozzle, directed vertically downwards on top of the tool. After surface-finish tests had been run on the lathe, the discs were photographed using a magnification of 40 diameters. The discs were then tested for surface roughness using a profilograph, the fundamental principles which are shown in Fig. 1, on this page. This machine makes it possible to obtain an enlarged profile of the surface by traversing the surface in a straight line in the bottom of the cut with an exceptionally sharp-pointed diamond. Movements of the diamond tracer *a*, Fig. 1, cause a mirror *b* to reflect a light beam, the path of which is recorded, highly magnified, on a photographic film on a drum *c*. In Fig. 1, *d* is the specimen, *e* a hinge and *f* a support for the diamond tracer and mirror; and *g* and *h*, the source of light and a lens, respectively. In all tests the vertical magnifications were × 1,000, and the horizontal magnifications were × 32.

The Effect of Cutting Speed.—In order to determine the effect of cutting speed, the S.A.E. 3140 steel in the normalised and annealed condition was cut dry, at speeds ranging from 9·7 to 461 ft. per minute. The best finish is obtained at the highest speed. Profilograms of the path of the beam, as it was deflected by the motion of the diamond point while being drawn over the cut surface in the bottom of the cut, are shown in Fig. 2, below, the figures given under each profilogram representing the cutting speed in feet per minute. While the appearance of the three surfaces at the lower speeds of 9·7 ft., 28 ft., and 49 ft. per minute seems to be very different, the profilogram shows that there is not a great deal of difference in irregularity. There appears to be a definite improvement when a speed of 95 ft. per minute is reached. If the speed is increased further, however, the surface quality is improved markedly. From the profilogram, as well as from visual observation, the surface at 283 ft. per minute is very much better than the same surface for all lower speeds. The vertical steps caused by torn metal are very small and of the order of 0·0002 in., as compared with the scale in the lower right-hand corner of Fig. 2. The profilogram for the highest speed of 461 ft. per minute is practically a continuous straight line which is maintained for all higher speeds.





It appears from this study, as well as from others of a similar nature, that, at the lower speeds, the chip is removed from the main body of metal by means of a large built-up edge. The cutting edge of the tool actually clears the machined surface and gives vertical irregularities on the torn surface, as shown by the profilogram, of from 0·002 in. to 0·0025 in. As the speed is increased, the built-up edge becomes smaller and recedes from the cutting edge so that the cutting edge itself actually produces the machined surface. The speed at which this occurs seems to be the optimum speed and should be obtained whenever good surface quality is desired. It is for this reason that cemented-carbide tools, or other tools which permit high cutting speeds, give a similar smooth machined surface.

Influence of Cutting Fluids.—With definite indications that the maximum influence of cutting speed, when cutting dry, occurred for the speeds from 90 ft. to 461 ft. per minute, as shown in Fig. 2, this range of speeds was selected for a study of cutting fluids and their influence on surface quality. The cutting fluids used in this study are: (*a*) An emulsion of 1 part oil to 16 parts distilled water; (*b*) a sulphurised-mineral oil containing 3·3 per cent. sulphur and having a viscosity of 110 Saybolt seconds at 100 deg. F.; (*c*) a sulphurised-base oil made by mixing 1 part sulphurised-lard oil containing 12 per cent. sulphur with 8 parts plain mineral oil, having a viscosity of 110 Saybolt seconds at 100 deg. F.

While taking a facing cut as described, the various cutting fluids were applied at the rate of 1 gallon per minute. The photographs taken, as well as the profilograms, appeared to show little difference in surface quality at the cutting speed of 283 ft. per minute for the various cutting fluids. It actually appears that the surface produced when cutting dry is best. At the highest cutting speed of 461 ft. per minute, the surface quality when cutting dry, with the 1-16 emulsion, and with the sulphurised-mineral oil, appears to be better than that produced with the sulphurised-base oil. It is apparent, however, that, when cutting dry, as well as when cutting with the emulsion and the sulphurised oils, an increase in speed makes a great improvement in the quality of the machined surface.

The influence of the cutting fluids was shown on discs normalised and annealed. Two additional discs were re-heat treated by giving only a normalising treatment. One of these discs was faced when cutting dry, and the second when the sulphurised-base oil was applied. The profilogram showed that the character of the finish of the normalised disc at 95 ft. per minute is quite different from that produced at the lower speed of 49 ft. per minute. The latter surface consists of numerous deep depressions, whereas the former consists of depressions of approximately the same depth, which occur less frequently. The profilogram for the normalised structure at 95 ft. per minute was definitely superior to the corresponding surface of the normalised and annealed structure cut at 94 ft. per minute. In the same manner, a high-quality surface is obtained on the normalised structure at a speed of 248 ft. per minute, whereas, the surface for the normalised and annealed structure at 283 ft. per minute definitely has not yet reached the best quality. The profilograms of the normalised structure at 248 ft. per minute appear to be similar to those of the normalised and annealed structure at 461 ft. per minute.

In conclusion, it was seen that the best surface quality for the normalised steel occurs at an optimum speed considerably lower than that for the normalised and annealed disc. The surface quality at the lowest speed is slightly better for the sulphurised-base oil than for dry cutting. There appears to be little difference, however, at the highest speed, unless perhaps it is in favour of dry cutting.

Influence of Heat Treatment.—Four discs were given the following heat-treatments: (*a*) As received, normalised and annealed, Brinell hardness No. 202; (*b*) heated to 1,500 deg. F. for 1 hour and quenched in oil; tempered at 600 deg. F. for 2 hours, Brinell hardness No. 460; (*c*) heated to 1,500 deg. F. for 1 hour and quenched in oil, tempered at 1,200 deg. F. for 2 hours, Brinell hardness No. 255; (*d*) normalised by heating to 1,600 deg. F. for 1 hour and air cooling, Brinell hardness No. 277. Each disc was given a facing cut. The experiments showed that the optimum speed for producing the best surface quality, at which time the cutting edge of the tool actually does the cutting, occurs at lower speeds for the structures of higher hardness. For example, the surface quality on the disc quenched at 1,500 deg. F. and tempered at 600 deg. F., having a Brinell hardness of 460, is poor at 28 ft. per minute. It appears that the optimum speed is 95 ft. per minute. The optimum speed for the steel quenched at 1,500 deg. F. and tempered at 1,200 deg. F., having a Brinell hardness of 255, appears to be 280 ft. per minute. This compares favourably with the speed for the normalised disc, having a Brinell hardness of 277, although it appears that the optimum speed for the normalised disc should be slightly higher. The optimum speed for the normalised and annealed bar, having a Brinell hardness of 202, is approximately 461 ft. per minute.

At the intermediate speed of 95 ft. per minute, the specimen quenched at 1,500 deg. F. and tempered at 1,200 deg. F., having a Brinell hardness of 255, had a finish greatly superior to the specimen normalised at 1,600 deg. F., having a Brinell hardness of 277. From this study, it appears that a good surface quality can be obtained on the steel in any heat-treated condition if the optimum speed is reached, but that the optimum speed for this best finish is lower for the harder steels.

General Conclusions.—For the S.A.E. 3140 steel in a normalised and annealed condition, when cut dry, the surface quality produced at low cutting speeds, as observed from photographs and profilograms, is poor. As high speeds are reached the surface quality is greatly improved. At a certain minimum speed, called the optimum speed, the cutting edge of the tool actually produces the machined surface which is superior to the surface at all lower speeds in which the chip is removed by means of a built-up edge. Photographs and profilograms show little difference in surface quality at high cutting speeds when various types of cutting fluids are used. At low speeds, however, it appears that the surface quality is improved as compared with dry cutting when a cutting fluid, consisting of a sulphurised-mineral or sulphurised-base oil, is used. The optimum cutting speed for each of several structures is lowest for the hardest steel and highest for the softest steel. It appears also that the surface quality changes but slightly as the speed, cutting fluid, or structure is changed for values of cutting speed above the optimum.

* Paper entitled "Surface Quality of an S.A.E. 3140 Steel", contributed by the Special Research Committee on the Cutting of Metals and presented at the annual meeting of the American Society of Mechanical Engineers, New York, December 2–5, 1940. Abridged.

THE NORWICH SCHEME OF TRAINING IN ELECTRICAL ENGINEERING.*

THE Norwich scheme of training in the Corporation Electricity Department was approved by the Norwich Electricity Committee and Council in 1941. The primary purpose of the scheme is to ensure that entrants to the Electricity Department are carefully selected and that they shall receive such training as will make them good engineers, equipped to carry out satisfactory work in the posts in the electricity supply industry for which they are found by experience to be suitable. The scheme is designed to encourage trainees to take a close personal interest in their work and studies. Full cognisance will be taken of the character, ability and industry of each trainee, who will be given the opportunity of filling such posts in the department as become vacant. The scheme is designed to offer no obstacle to the trainee's progress, whatever his origin or previous limitations.

The responsibility for organising the training scheme rests in part with the City Electrical Engineer and the head of each of the four main sections of the Electricity Department and in part with the trainees, through the operation of a Joint Training Committee. This consists of (*a*) the Staff Side, comprising the City Electrical Engineer, (chairman), the Deputy Chief Electrical Engineer, the heads of the four sections of the department, and two other members (not necessarily members of the Electricity Department), whom the Staff Side may decide to co-opt; and (*b*) the Trainees' Side, comprising the four Department Trainees (one from each section), and one Section Trainee from each Section, the latter being elected annually by the remaining Section and Ordinary Trainees in each section. The Joint Committee normally meets once every three months. The City Electrical Engineer normally deals directly with the head of the section in all matters affecting the discipline, welfare and progress of trainees in his section, and the latter is directly responsible for such discipline and progress being satisfactory.

Successful candidates are provided with training in one or more sections of the Department. There are three classes of trainees, the Department Trainee, the Section Trainee, and the Ordinary Trainee. Vacancies for these posts are advertised, and candidates who possess the necessary academic qualifications are chosen as a result of their character and personality as indicated during an interview with the City Electrical Engineer and a selection committee of the senior staff.

Department Trainees.—Candidates should be 16 or 17 years of age, and must have passed the Intermediate B.Sc. examination of London University. They will be required to continue their studies at the Norwich College with a view to taking the Final B.Sc. examination, preferably at the age of 21 years. Upon being appointed, a candidate will serve for a probationary period of six months, and, if his work and conduct prove satisfactory, indenture forms will then be signed. At the end of his indenture period he will receive his indentures, endorsed with a record of his training and achievements. Training will be given up to the age of 21 in the following sections of the Electricity Department and for approximately a year in each, although no guarantee can be given as to the exact nature of the training and period in each section:—(*a*) Wiring and installation; (*b*) mains and sub-station; (*c*) power station; and (*d*) meter.

At the conclusion of this preliminary training, the head of the section will furnish to the City Electrical Engineer a report on the candidate's progress and general abilities. The Corporation reserve the right to terminate the training and the services of the trainee at any time if his work or academic career proves unsatisfactory. When the Department Trainee reaches the age of 21 years, he may be given the opportunity of a continued period of training up to the age of 24 years, such training to include work in the sales and commercial section, and in general administration and management. This option of extended training will be entirely at the discretion of the City Electrical Engineer, and will only be granted where a Department Trainee shows that he possesses ability which will fit him to undertake administrative and managerial duties. Opportunities may be provided during this period for the trainee to enter the works of a cable maker, switchgear or electrical-instrument maker for approximately one year, or to obtain experience with another electricity undertaking.

Section Trainees.—Candidates should be 16 years of age and should have obtained the School Leaving Certificate, preferably with sufficient credits to give exemption from the London Matriculation examination. Successful candidates will be required to continue their courses of study with a view to passing the full examination (Parts 1 and 2) of the Institution of Electrical Engineers and/or the Institution of Mechanical Engineers, or to take the London Intermediate B.Sc. (Engineering) examination. Those appointed will normally be given training, until they are 21, in the particular section in which there is a vacancy and to which they are appointed. Those whose progress is the most satisfactory may also be given the opportunity of obtaining training in other sections during the last two or three years of their training. If a Section Trainee passes the Intermediate B.Sc. examination subsequently to his appointment, and if his general work and progress are good, he will be eligible to become a Department Trainee under indenture, if there is a vacancy in this grade.

Ordinary Trainees.—Any boy who desires to enter the Electricity Department of the Corporation need not be deterred by reason of not having specified academic qualifications. In such a case he may make application to enter as an Ordinary Trainee. If he is successful in a personal interview, he will be appointed to the section in which there is a vacancy. The Electricity Committee will provide free educational facilities at the Norwich College, as for the other classes of trainees, and satisfactory reports from the Principal of the College, as well as on his general work, will be a condition of the training being continued. Ordinary Trainees will receive the same training as Section Trainees, and, if they succeed in passing the Preliminary (Part 1) examination of the Institution of Electrical Engineers, will be entitled to the same privileges as to training in other sections during the last three years of their training as for Section Trainees.

All boys who enter the Department other than on the clerical side, will be required to enter as either Ordinary, Section or Department Trainees. An Ordinary Trainee will normally receive training with a view to ensuring that, by the time he reaches the age of 21, he has learnt a trade which is available within the Electricity Department. These trades comprise, in the Mains Section, plumber jointer; in the Wiring Section, wireman; in the Meter Section, meter tester, repairer, fixer, or reader; in the Building Section, carpenter, bricklayer, plumber, or painter; in the Thorpe Power Station Section, fitter and turner, or shift operator as turbine driver or stoker.

Every endeavour will be made to ensure that a boy is placed at a trade for which the City Electrical Engineer and the Joint Training Committee consider he is best fitted, but no guarantee can be given that a boy will be given employment after he reaches the age of 21. Subject, however, to satisfactory work and conduct and to satisfactory reports from the Technical College, each boy will be given training until he reaches the age of 21, by which time he will have learned the trade to which he has been placed.

All trainees will be required to undertake, during the whole of their training, courses of study at the Norwich College of a type approved by the Principal of the College in conjunction with the City Electrical Engineer. These courses will, in all cases, involve regular attendance at evening classes, and where the Principal recommends that such evening study should be supplemented by part-time day courses, arrangements will be made for the trainee to attend such courses. There will be no reduction in remuneration for time spent at the College during normal working hours, and, subject to satisfactory reports, the cost of the study course will be borne by the Electricity Department.

The rates of payment during training, as fixed in November last, are, for Department Trainees, 1*l.* 6*s.* 5*d.* a week on attaining the age of 17, 1*l.* 12*s.* 6*d.* a week at 18, 1*l.* 18*s.* 7*d.* at 19, 2*l.* 4*s.* 9*d.* at 20, and 2*l.* 10*s.* 0*d.* at 21. A Department Trainee who continues in the service of the Department after attaining the age of 21, whether following the extended course of training or otherwise, will normally rise by equal annual increments from the salary at the age of 21 to the lowest grade of the National Joint Board Wage Schedule (Grade 10B), on attaining the age of 24, the salary for which is at present approximately 232*l.* per annum. The granting of these increments will be subject to the approval of the Electricity Committee, who will be guided in their decision by the reports submitted to them by the City Electrical Engineer. The Electricity Committee may defer or anticipate the granting of these annual increments, depending upon the evidence of these reports.

Section Trainees, on attaining the age of 16, receive 16*s.* 8*d.* a week; at 17, 1*l.* 0*s.* 7*d.*; at 18, 1*l.* 4*s.* 6*d.*; at 19, 1*l.* 11*s.* 4*d.*; and at 20, 2*l.* 3*s.* 1*d.* The scale for Ordinary Trainees, at corresponding ages, is 16*s.* 8*d.*, 1*l.* 0*s.* 7*d.*, 1*l.* 4*s.* 6*d.*, 1*l.* 11*s.* 6*d.*, and 2*l.* 3*s.* 1*d.* a week.

The progress reports of trainees, provided for the City Electrical Engineer by the Principal of the Norwich College, will not be based primarily upon examination results, but will assess the general willingness and effort displayed by the trainee in his studies.

Each course will be of a type approved by the Principal in conjunction with the City Electrical Engineer. It is anticipated that certain of the approved courses will include training for executive and administrative posts.

Syllabus of Training.—Department Trainees will spend about a year in the Mains and Sub-station section. During the first two months, they will act as joiners' mates, and will receive instructions in trench digging and cable jointing. Every available opportunity will be afforded of experience in jointing both high-tension and low-tension cables, including work on live low-tension service joints. The next four months will be divided into periods of approximately one month each on the lay-out of sub-stations, rotary sub-station work, fault work, and protective gear. For the remaining six months, the Department Trainee will be appointed to one of the three County Districts, and will be required to live in the district to which he is appointed. He will spend approximately three months with a first-class linesman, in the capacity of linesman's mate, and, during the remaining period in the rural district, should take every opportunity to gain knowledge of survey of lines, erection and maintenance of overhead lines, sub-stations and switchgear. Opportunity will also be afforded to appreciate the various types of overhead-line design, and the Electricity Regulations referring to overhead lines, and to estimate the cost of erecting such lines to sub-stations.

Section Trainees will normally spend four years in the Mains Section, the training being divided approximately as follows: 1*st year*—six months on jointing, acting as jointer's mate, and six months in the Mains Drawing Office; 2*nd year*—City mains work, to include estimating and preparing extensions, fault-finding and general routine work; 3*rd year*—County mains work, with training applied particularly to overhead distribution; 4*th year*—Rotary sub-stations, static sub-stations, routine testing of protective gear, etc. Both Section and Department Trainees while in the Mains and Sub-station Section, will be required to be available outside office hours for fault duty, so as to become familiar with breakdown duty and repair work.

Department Trainees, while in the Meter Section will receive training in the following work: (*a*) workshop, about three months; (*b*) test room, about three months; (*c*) standards room, about four months; (*d*) meter installation, testing on site, about one month; and (*e*) inspection of installations, and routine work connected with consumers' premises, one month.

Section Trainees will receive training approximately as shown above for a Department Trainee, but for a period roughly four times as long. The first three months are to be spent with an outdoor representative in installing and testing meters on site, and in obtaining knowledge of the routine system of records appertaining to the Meter Section.

In the Sales and Contracting Section, Department Trainees receive training in the following work: Wiring for power, lighting, cooking, heating, etc. (installation and repairs), about 4 months; workshop, on repairs to domestic apparatus and motors, about 4 months; estimating, testing, records, etc., in Installation Superintendent's office, about 4 months. Section Trainees will receive general training in repairs and installation, care being taken to ensure that they have an opportunity to acquire knowledge of the various classes of work. The time allowed for each class of work is divided into two periods, to ensure that, should they become eligible at the end of two years for promotion to a Department Trainee, they will have obtained a good all-round experience in each class.

The following are the general principles of training which will be followed in connection with Trainees, either Department or Section, who are appointed to the Thorpe generating station of the Electricity Department. A Department Trainee will normally receive training at the generating station for one year in the first instance. This training will be divided into periods of approximately three months each in the following sections of the stations: (*a*) technical section, covering preparation of reports, etc.; (*b*) boiler-house operation; (*c*) turbine-house operation; (*d*) mechanical maintenance work.

The Section Trainee who is appointed to the generating station will normally receive training for about four years, and in this case he will be trained in the four main sections of the work referred to above, except that at least six months will be spent in the machine and fitting shops. The trainee should then be capable of taking a more responsible position, such as that of shift work in the control room as a junior switchman, or of carrying out more responsible technical work. No hard and fast rule can be laid down as to the position to which a Section Trainee would be appointed at the end of his training, and it is desirable that, if he is progressing well in his academic studies and requires to take a part-time day course, arrangements should be made so that his academic training will not be interrupted by shift work; and his transfer to a position involving shift work would probably be delayed until the academic training was completed.

* Abstracted from the Syllabus issued by the Norwich Corporation Electricity Department. See letter to the Editor on page 34.

WAR-TIME FACTORY LIGHTING.

BLACK-OUT requirements, while forming little more than a war-time nuisance to the householder, are of the utmost importance in the case of factories. Saw-tooth roofs with continuous north lights may be dealt with by painting over the lights or by covering them with sheeting. Such methods, however, involve the use of artificial lighting during daylight; and the alternative of withdrawable blinds cannot be relied upon to remain wholly satisfactory. It is, of course, impossible to specify a procedure suitable for all cases, but the method of "blacking-out" described below certainly merits careful attention and seems to meet many of the objections raised with other systems. The factory concerned was originally completely blacked-out by means of hard wall-boards fitted to the outside of all the north lights and other windows. The roof was effectively camouflaged, as the external coverings of the north lights presented a continuous surface for an unbroken scheme of painting. The covering naturally involved artificial illumination during daylight, and after working with this for some considerable time it was decided that part of the obscuration should be made to open and shut, so that some daylight at least could be admitted. But, as the roof lights covered an area of at least 550,000 sq. ft., manual operation would, clearly, require too much labour and time, the latter factor, it will be realised, being of great importance. As it is, a complete black-out for night work and a restoration of the interrupted camouflage pattern for day work can be secured in 15 seconds by means of a push-button.

The roof lights are in continuous strips for the full length of the steeply-pitched north-facing sides of the roofs and, as already stated, were covered with panels of wall board. Every alternate panel was removed and was fixed, in a similar position to that which it originally occupied, in a frame. This frame was arranged to move longitudinally over the whole row of lights, grooves to permit of this movement being cut in Vee-sections attached to the glazing bars. The resulting arrangement can best be visualised by comparison with the ordinary slotted louver commonly fitted to control air to a domestic heating stove, etc. Each end of the frame is fitted with a steel cable which is passed at the ends of the span over spring-tensioned pulleys. The cable is, of course, continuous and at one point is passed round the drum of a winch mounted on an interior wall of the factory. The winch is driven, through reduction gearing, by a ¼-h.p. direct current compound-wound reversing motor. The opening and closing movements of the frame are obtained by reversal of the motor which is controlled by forward and reverse contactors operated by two limit switches. These switches are tripped by fingers mounted on steel rods secured to the vertical portions of the cable, the rods travelling up and down through a distance equivalent to the movement of the sliding frame.

The panels in the frame retain their original painting so that when the frame is in the closed position the camouflage design is unbroken. When it is in the closed position the amount of daylight admitted is, naturally, only 50 per cent. of that passing through a completely unobscured row of lights, but even this amount has been found to have a markedly beneficial effect on the operatives, who, previously, had to work throughout a bright sunny day in the comparatively gloomy atmosphere of artificial light. It is not to be supposed that the whole of the roof lights are operated by a single motor; on the contrary, there is one ¼-h.p. motor for each span of roof lights having an area of approximately 1,000 sq. ft. Since a total of more than half a million square feet of roof lights is involved, over 500 of these motors are employed. The motors are run from 12 groups of storage batteries dispersed at convenient places in the factory. Each group consists of 20 12-volt batteries, trickle-charged.

The groups of batteries are housed in neat wooden cases, above which are the master contactor panels for charging, the contactors being operated from a time switch having a time-lag of 25 seconds. Each group of batteries is provided with a push-button control, so that each master contactor can operate its individual section of shuttering if required. The groups, moreover, are connected by means of underground armoured cable to a panel in the A.R.P. control room of the factory, an arrangement which enables the whole factory black-out to be controlled by means of a push button. In the event of damage to the electrical equipment the motors can be readily disconnected from the winches, which can then be operated by hand. The electrical equipment was supplied by Messrs. General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2. In addition to the motors and their switchgear, the installation required some 230,000 yards of cable and 150,000 ft. of steel conduit, as well as 450 sets of contactors and specially-designed starter panels, relays, etc. The installation of the equipment was carried out by Messrs. C. F. Anderson and Son, Limited, 13, Essex-road, London, N.1.

LABOUR NOTES.

THE Ministry of Labour and National Service estimates that in the first five months of this year the wage changes reported to it resulted in a net increase of about 1,000,000*l.* a week in the full-time wage rates of about 6,650,000 workpeople. In the corresponding period of 1940 about 6,240,000 workpeople received a net increase of wage rates amounting to approximately 1,170,000*l.* a week. Since the outbreak of war, the net increases notified to the Ministry have amounted to approximately 3,900,000*l.* a week.

The Secretary for Mines announced last week that in order to meet the needs of rising war production, restrictions were to be imposed as from July 1, on the amount of coal, coke, anthracite and manufactured fuel going to non-industrial premises that fall under the Fuel and Lighting Order, 1939. The restrictions, it was added, apply to houses, flats, hotels, clubs, institutions and offices not directly associated with industry and limit to one ton, the maximum quantity which may be delivered in any one calendar month except under licence from the local fuel overseer.

Two other age groups of men in industrial employment were called upon to register on Saturday last by the Ministry of Labour and National Service. All men born in the years 1898 and 1899 were required to register at an Employment Exchange on that date unless they had registered on April 5. On April 5 about half the men born in these years registered, but a large number of industries—mainly munitions industries and industries covered by the Board of Trade's Concentration of Production Scheme—were then excepted. On Saturday last, however, all the men born in 1898 and 1899 were required to register if they had not registered on April 5. No exceptions were made from the requirement to register, but, it was explained, that men engaged on vital work from which they could not be spared would not be transferred to other work.

A resolution calling for a national minimum wage for all workers in and around coal mines is to be submitted by the executive committee of the Mineworker's Federation of Great Britain at the annual conference of the organisation which opens at Ayr on Monday next. A resolution from Cumberland proposes that the minimum wage shall be 4*l.* 10*s.* per week with cost-of-living adjustments, and one from Scotland desires a Government subsidy "to be used to increase wages." South Wales urges nationalisation of the coal and all other basic industries, including rail and road transport, and the executive committee puts forward a scheme for the establishment of a national board of owners and men to take the place of the Central Committee which controls quotas and prices.

The increasingly important part played by women in industry is referred to in a statement issued by the Ministry of Labour and National Service. The position of 21 key firms is examined. In some of them, it is stated, women now number nearly half the total employed, and, in all, the proportion is being increased every week. One firm has 4,300 women out of a total of 9,000 employees. They carry out all phases of the manufacture of radio transmitters.

Discussing the subject of "Absenteeism" in the July issue of the *T. and G.W. Record*, Mr. Arthur Deakin, the acting general secretary of the Transport and General Workers' Union says:—"Personally, I do not accept the contention that there is any real problem from this angle. Certainly, consequent upon the long hours worked in many of our industries, a condition of physical exhaustion is produced which inevitably brings a reaction. People cannot go on indefinitely without a break; the strain and speed of workshop practice to-day are far too great. In many cases where overtime is being worked systematically—the trade unions having accepted this requirement—the hours worked are much too long and the demand made by certain employers is unreasonable. Whatever difficulty there may be related to continuity of employment it is clear that this is in a large measure due to overwork."

The May issue of the *Journal* of the American International Association of Machinists states that the executive council of the organisation has adopted a new policy for dealing with disputes in the defence industries. Since the approval of the earlier procedure, it is pointed out:—"(1) The Secretary of the Navy has openly injected the dictates of his office into negotiations between employer and employees, thereby limiting or retarding results of such negotiations. (2) Certain employers are attempting to reduce wages and overtime rates and alter conditions that had previously been established by agreement. (3) Employers are attempting to increase their profits by using small defence contracts as a reason for claiming defence exemption for the entire plant." In view of these and other "questionable practices," the Council say they are obliged to abandon the earlier policy and to substitute for it a new one.

Under the new policy, "whenever a controversy involving members of the International Association of Machinists arises in a plant or on a project or job which affects the National Defence Programme, that cannot be adjusted in conference between representatives of the management and the employees in accordance with our constitutional procedure and in conformity with the provisions of any specific agreement between the employer and the International Association of Machinists, the following procedure will govern:—(1) The services of the United States Bureau of Conciliation shall be invoked for the purpose of having a commissioner endeavour to bring about a settlement. (2) If, after a reasonable opportunity has been afforded the U.S. Conciliation to settle the controversy, no adjustment results, the Office of Production Management will then be requested to use its good offices to effect a settlement. Pending the efforts of the Office of Production Management, no strike sanction will be released, provided there is no undue delay in the handling of the controversy by representatives of that agency."

The employment of women on mechanically-propelled vehicles in Germany is regulated by an Order issued in October last. The employment of girls under 18 years of age is prohibited on mechanically-propelled vehicles belonging to the public transport services (including railways) and industrial undertakings, except in cases where their employment on such vehicles represents only a relatively negligible proportion of their total activity. The employment of women over 18 years of age, must not exceed 9 hours per day, or in the case of railways, 54 hours per week. No woman of whatever age, may be employed as driver of a mechanically-propelled vehicle, the live weight of which exceeds one and one-half metric tons (2·1 metric tons in the case of electrically-propelled trucks with a maximum speed of 25 kilometres per hour). The labour inspector, in agreement with the competent authority for local transport, may in cases of special urgency, permit the employment of women as drivers of trams and trolley buses. In such cases the hours of employment must not exceed 8 per day.

It is estimated that when the quotas for the current year have been admitted, Germany will have at its disposal 320,000 Italian workers. That will include, of course, the agricultural workers—nearly 60,000, it is reckoned—transferred for temporary service under earlier agreements between the two Governments. The later quotas are expected to consist very largely of supervisory staff and workers in the iron and steel, metal-working and engineering industries, and, as was mentioned in these notes a week ago, hours of work in the Italian industries affected have been lengthened in order to make up for their consequent loss of skilled and specialist labour power.

A steady drain on Germany's man power for military service seems to be indicated by the fact that hotels and restaurants are suffering from a shortage of waiters and other specialised staff. In Italy, on the other hand, owing to the war, there is little or no tourist traffic, and consequently many specialised hotel workers are idle. About 3,000 of them have, therefore, been transferred, under agreement, to Germany.

The Administrator of Public Contracts Division of the United States Department of Labour has decided that the employment of home workers in the execution of Government contracts subject to the Walsh-Healey Public Contracts Act is generally a violation of that measure. This ruling, the *International Labour Review* states, is based on the official interpretation that a "manufacturer" or a "regular dealer" within the meaning of the Act must have regular premises in which his business is conducted, so that a contractor holding a contract as a manufacturer must perform the work under the contract in his own factory. The Administrator has advised contractors using home workers that if they continue this practice, it will be necessary for him to notify contracting officers that these contractors are not qualified to hold Government contracts subject to the Public Contracts Acts.

The Swedish Social Board has published the results of an inquiry into the hours worked during the week November 17 to 23, 1940, and compared them with the results of a similar inquiry made in 1937. They show a reduction in average weekly hours in industry from 47·2 to 46·6. The proportion of workers laid off, or placed on short time, has increased from one in twenty to one in seven.

TEMPERATURE TESTS ON MOTOR-OMNIBUS BRAKE-DRUMS AND TYRES.

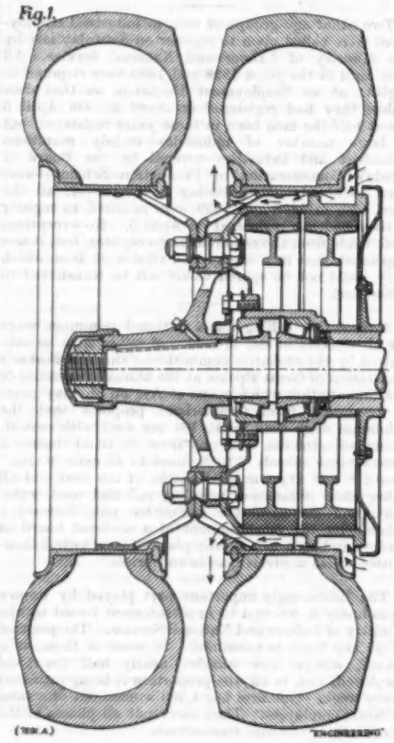
SINCE excessive temperatures adversely affect the durability of the tyres and tubes of motor vehicles and are mainly due to the over-heating of brake drums and wheel rims, a full investigation of the problem is likely to prove of value. The results of such an investigation are given in the first interim report on laboratory measurements on this subject published by the Institution of Automobile Engineers, 12, Hobart-place, London, S.W.1. This report, entitled "The Over-Heating of Tyres and Brakes on 'Buses" has been drawn up for the Automobile Research Committee by Mr. C. G. Williams, M.Sc., and, as stated in it, does not claim to deal with the whole subject, the scope of the tests being limited to the examination of a particular wheel and brake drum assembly. At the same time, the results obtained are distinctly informative and the brief summary given below should prove of interest to the manufacturers of brake linings and of cast-iron brake drums, since the former are concerned with the results of excessive heat on the wearing and frictional characteristics of the linings, while the latter are faced with the problem of surface cracking at high temperatures. The vehicle operator is interested because maintenance and disturbance of the operating schedule must both be kept to a minimum. Further, the tyre manufacturer has to bear the full burden, in the case of tyre mileage contracts, of the shortened life, even though the product supplied may be entirely satisfactory.

The apparatus employed in the investigation consisted of a complete back axle and wheel assembly of the type shown in Fig. 1. All four wheels were in place though only two are shown in this figure. The propeller shaft of the test assembly was driven by a 20-h.p. variable-speed direct-current motor. Two of the wheels, *i.e.*, the pair on which the measurements were made, were free to rotate although subjected to a continuous braking force applied to the normal brake rod mechanism, the load being measured on a spring balance. The other pair of wheels were prevented from rotating by a torque arm, fitted with a dashpot, and a spring balance. The balance readings indicated the braking torque developed at the "measurement" end of the axle and transmitted through the differential which, incidentally, withstood this unusual treatment satisfactorily. The power transmitted was, however, low; usually about 2 h.p. The points at which the temperature measurements were made are indicated by the numbers in Figs. 2 and 3, opposite. For the rotating parts, Nos. 1, 2, 3 and 4 were all for measuring temperatures of the brake drum, No. 5 was in the wheel hub, No. 6 in the wheel disc close to the hub, No. 7 in the rim nearly opposite No. 3 in the drum, No. 8 in the detachable flange, and No. 10 in the integral flange of the rim. Points Nos. 9, 11 and 12 were in the walls of the tyre, the first two being indicated in Fig. 2, while No. 12, not shown, was in the tread $\frac{3}{4}$ in. below the surface.

The temperatures at these points were obtained by means of copper-Constantan thermocouples the leads from which were soldered to pairs of copper and Constantan slip rings carried on a fixed frame outside the wheel assembly. Selection of the different couples was effected by sliding a pair of copper and Constantan brushes on to the appropriate pair of slip rings, the brushes being coupled by copper and Constantan leads to a potentiometer. The temperature of the non-rotating parts was ascertained by thermocouples connected directly, though, of course, through suitable switches, to the measuring potentiometer. Points Nos. 13, 14 and 15 gave the temperatures near the surface of the brake linings, points Nos. 13 and 14 being shown in Fig. 2, and No. 15 being opposite to No. 14 on the bottom half of the brake and not appearing in the figure. The temperature of the web of one of the brake shoes was taken at point No. 16, that of the bearing housing at point No. 17, of the axle casing at point No. 18, and of the dust shield at No. 19. Point No. 20 indicates an alternative position of point No. 2, which, in some of the tests, was moved so as to project about $\frac{1}{4}$ in. from the drum surface, its reading in this condition being thus of the air temperature in the clearance space between the rim and the drum and not that of any solid part. During a test the wheel was rotated at a fixed speed and with a constant braking torque. Readings of temperature were taken at half-hourly or hourly intervals, approximate stability being reached after about six hours' running.

The results of some of the tests are shown in Table I, opposite. The letters in the first column of this table have been added for identification purposes only and do not necessarily indicate the order in which the tests were made. The figures in the top row indicate the points at which the temperature measurements were made, as shown in Figs. 2 and 3. The other figures are the observed stabilised temperatures in deg. C. corrected for a standard atmospheric temperature of 15 deg. C. In some instances the tests were repeated several times. The majority of the tests were carried out with a rotational speed of 100 r.p.m., which corresponds to a road speed of 11 m.p.h., and the energy input was 2·14 h.p. In considering the test results, it may be as well to comment here on three possible objections to the methods employed to obtain them. Firstly, there was no forward movement of the tyre and no cooling effect due to this cause, as there would be on the road, but the conditions of the test approximate with sufficient accuracy to those obtaining with a fully shrouded wheel. Secondly, effects due to the generation of heat within the tyre itself were absent, these effects tending to increase the tyre and rim temperatures to higher values than those due to brake drum heating alone. Finally, a continuous application of a relatively low braking torque does not normally occur in service, in which comparatively "fierce" brake applications of short duration are made. This, however, is of little importance in relation to the transmission of heat from the brake drum to the wheel rim, as service records show that, after a number of hours of operation, the outside surface of the brake drum reaches a moderately steady temperature, which determines the rim temperature. In spite of the differences between test and service conditions, therefore, the results yield a considerable amount of useful information. As regards dimensions, it may be mentioned that the brake drum was 17 in. in internal diameter and had a maximum thickness of $\frac{1}{2}$ in. The rim was $19\frac{7}{16}$ in. in internal diameter, so that the clearance was $\frac{3}{4}\frac{3}{2}$ in. The rib seen in Fig. 2 had an external diameter of $19\frac{1}{4}$ in., and was $\frac{1}{4}\frac{1}{6}$ in. wide.

Fig. 1.



Referring to Table I, test *a* was of a standard wheel with no ventilation and arranged as shown in Fig. 1. The following results may be noted: There was a temperature difference of 12 deg. C. between points Nos. 2 and 3, this being the temperature gradient through the drum material. Between point No. 3 and point No. 7, there was a temperature drop of 87 deg. F., and a further drop between point No. 7 and the rim flanges, the integral flange on the right being 21 deg. C. higher than the detachable flange on the left. There was also a temperature drop between points No. 7 and No. 6, which would seem to suggest that heat flows away from, and not to, the rim by way of the wheel disc. The wheels were then run at 200 r.p.m. with the same energy input of 2·14 h.p., the braking torque being half that at the lower speed. This test, *b*, shows that by doubling the rotational speed, at constant heat output, a reduction in temperature was secured at all the points observed and the importance of air cooling is demonstrated. In order to study heat transmission due to metallic contact between the brake drum and wheel disc by way of the hub, asbestos washers $\frac{1}{4}$ in. thick were inserted between the hub and wheel disc round the coupling bolts; that is between test points 5 and 6. The results are shown in test *c*. The temperature of the drum was raised, but the temperature of the rim, point No. 7, was unaltered, as compared with test *a*. The amount of heat transmitted to the rim by metallic conduction was small and the conclusion was reached that no appreciable improvement can be expected from thermal insulation of this type.

In test *d*, an attempt was made to ascertain the effect of radiation on heat transmission, and the inside surfaces of the rim and disc were coated with aluminium foil, as shown by the dotted line in Fig. 2. The foil was 0·007 mm. thick, and was secured by an adhesive. It is a very good reflector of heat. Comparison of the figures of test *a* and test *d* will show that, as regards the rim, this insulation was effective, as the temperature at point No. 7 in test *d* was 88 deg. C., as against 97 deg. C. in test *a*. But the cooling of the rim was secured at the expense of the heating of the brake drum, the temperature at point No. 3 having risen from 184 deg. C. in test *a* to 208 deg. C. in test *d*. There was also a rise in the temperature of the brake lining at points Nos. 13 and 14, and even in that of the bearing housing, point No. 17. It is obviously unwise, therefore, to adopt any method for the prevention of heat transmission to the wheels, rims and tyres which may have an adverse effect on brake temperatures.

Since the results of the investigations on the amount of heat transmitted to the rim by conduction and radiation normally showed small increases, it was inferred that transmission by convection was an important factor. The convected heat has to cross the air gap between the drum and the rim, and the amount of heat so crossing is clearly affected by the movement of air through the gap in an axial direction. Smoke tests indicated that there was a circulatory movement, as indicated by the arrows in Fig. 1, this movement being initiated by an impeller effect obtaining by the rotation of the two adjacent tyres, the air outlet in the inner wheel disc being the valve holes. The first step was to ascertain the result of stopping this circulation, which was done by putting a paper seal across the inlet, as indicated by a chain-dotted line in Fig. 2. A comparison of the temperatures of test *e* with those of test *a* will show an appreciable temperature increase at most of the points. The increased difference between points Nos. 9 and 11 in test *e* is accounted for by the fact that cool air was being drawn in through the valve holes in the wheel disc of the outer tyre and flowed over the area in which point No. 9 was situated. But, if the valve holes in the outer wheel disc were sealed, it was logical to assume that the suction effect above referred to would be concentrated on the inner wheel base. This sealing was accordingly done, but practically no improvement resulted. Other means for increasing the ventilating effect were, therefore, sought.

In the first place, two vanes, approximately of the shape shown in Fig. 3, were fitted diametrically opposite, and adjacent to, the two valve holes, the vanes being fixed by a lug clamped between the two wheel discs. The object of these vanes was to initiate a centrifugal impeller effect and the results are shown in test *f*, Table I. Compared with test *a* a general appreciable reduction of temperature is noted, particularly at the point No. 20. The number of vanes was then increased to eight and the shape was exactly as shown in Fig. 3. A further slight improvement resulted but not so much as might have been expected, so it was decided to increase the air outlet area by drilling the wheel disc with eight holes each $2\frac{1}{4}$ in. in diameter, the holes being spaced between the valve holes. These have an area of about 7 sq. in. each, so that the outlet area was increased by the extra holes from 14 sq. in. to rather more than 42 sq. in. The results, tabulated in test *g* show a marked improvement without interfering in any way with the clearances between the brake drum and the rim or with the general design of the drum. At a speed of 200 r.p.m. the decrease in temperature at all the points was still greater, as will be evident from the results tabulated for test *h*, both tests *g* and *h* being compared with test *a*.

It was then assumed that the presence of the circumferential rib on the exterior of the brake drum checked the free flow of air between the drum and rim, since the clearance between the periphery of the rib and the inner surface of the rim was only $\frac{1}{16}$ in. The rib was, therefore, turned off the drum, an unobstructed annular space of $\frac{3}{4}\frac{3}{2}$ in. being thus obtained. The experiments were carried out at a speed of 100 r.p.m. with the inner wheel arranged as for test *g*. The results of the experiments with the rib removed are tabulated under test *i*. Comparing this test with test *g*, it will be seen that the removal of the rib had the effect of considerably increasing the temperature of the drum at points Nos. 1 and 3. At the same time, a fall of temperature is evident in the rim at point No. 7, and in the tyre wall at point No. 9. Similar results were obtained when the speed was increased to 200 r.p.m. The vanes were then removed and

TEMPERATURE TESTS OF BRAKE-DRUMS AND TYRES.

Fig. 2.

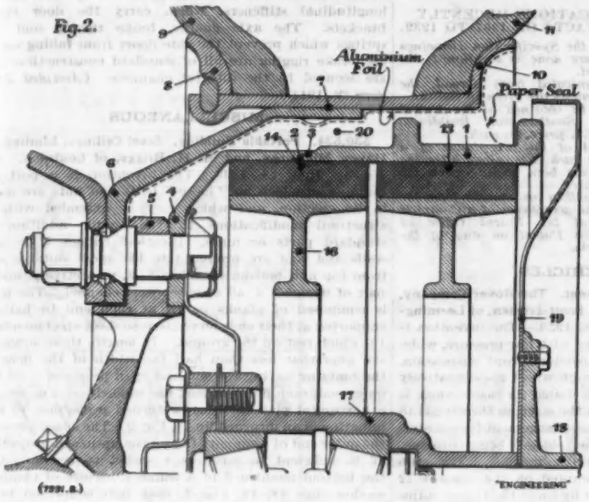


Fig. 3.

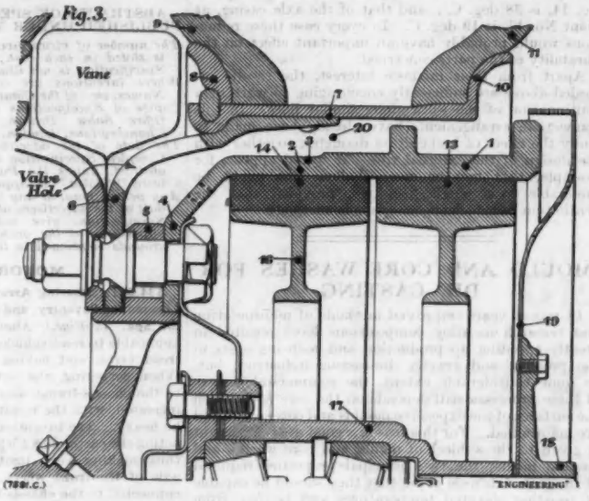


TABLE I. TEMPERATURE TESTS OF WHEEL AND BRAKE ASSEMBLY.

Test No.	Brake Drum.				Hub.	Disc.	Rim.		Tyre.	Rim.	Tyre.		Brake Lining.			Shoe.	Housing.	Casing.	Dust Shield.	Air Space.	Conditions of Test.
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	
a	173	196	184	121	111	79	97	70	61	91	74	24	170	177	169	144	93	68	85	146	Both wheels unventilated. 100 r.p.m.
b	185	—	181	114	103	88	87	63	53	76	55	—	174	168	—	135	90	66	—	134	Ditto. 200 r.p.m.
c	188	200	190	132	124	85	97	71	62	89	70	—	172	178	—	144	97	69	83	—	Insulating washers between drum and rim. 100 r.p.m.
d	195	214	208	135	122	83	88	69	61	82	70	—	196	196	—	159	104	75	92	—	Increased thermal reflectivity of rim. 100 r.p.m.
e	186	206	200	129	119	87	105	75	63	101	82	—	183	192	—	153	100	72	89	—	Air circulation blocked between drum and rim. 100 r.p.m.
f	167	—	182	121	111	80	89	59	50	78	56	—	168	177	—	141	87	63	—	126	2 radial vanes. Non-ventilated wheel. 100 r.p.m.
g	139	—	150	100	92	—	76	—	55	—	—	—	—	162	—	132	82	60	—	114	8 radial vanes. Ventilated inner wheel. 100 r.p.m.
h	122	—	133	88	80	—	60	—	43	—	—	—	—	155	—	124	82	60	—	89	Ditto. 200 r.p.m.
i	177	—	173	95	85	—	54	—	32	—	30	—	141	160	—	125	77	58	—	105	Rib on drum removed. 100 r.p.m.
j	164	—	160	91	83	—	53	—	27	—	27	—	137	151	—	120	71	53	—	89	Ventilating holes in drum. 100 r.p.m.
k	174	—	152	101	94	68	83	63	55	75	61	—	149	138	—	110	66	51	—	145	Dust shield removed. 100 r.p.m.
l	147	171	160	101	94	71	89	57	57	84	68	—	150	150	—	107	77	58	71	—	Air blast inside drum. 100 r.p.m.
m	179	—	176	131	109	74	99	74	60	84	58	—	160	182	—	144	94	69	—	158	Same as in test *a*, but new drum used.
n	153	—	151	101	83	51	61	37	31	52	38	—	149	162	—	127	81	61	—	132	Same as in test *g*, but both wheels ventilated.
o	195	—	192	136	110	79	90	74	58	82	60	—	190	183	—	150	100	70	—	152	Same as in test *a*, but drum rib partly removed.
p	145	—	142	92	71	46	46	37	32	33	27	—	153	144	—	116	75	53	—	104	8 radial vanes. Both wheels ventilated. Drum rib partly removed.

further runs made at 100 r.p.m. The results obtained showed an increase in drum temperature and a reduction in rim temperature. The probable explanation of these results is that the rib sets up a state of turbulence in the clearance space, and this turbulence encourages the flow of heat from the drum to the rim. If the results of test *i* are compared with those of test *a*, it will be evident that the drum temperature of the former, at point No. 3, is moderately reduced by the alterations, being 184 deg. C. in test *a*, as against 173 deg. C. in test *i*. The rim temperature, at point No. 7, was, however, considerably reduced, being 97 deg. C. in test *a* and 54 deg. C. in test *i*, this latter being a safe temperature while 97 deg. C. is considered a dangerous one.

It was then considered worth while to investigate the effect of drilling holes in the conical part of the brake drum in order to induce a flow of air inside the drum. Ten holes, each $\frac{3}{8}$ in. in diameter, were accordingly drilled in the position shown by dotted lines in Fig. 3, and runs were made at 100 r.p.m. The assembly otherwise, had eight vanes, eight extra holes in the wheel disc as before, and the drum rib removed. The results are tabulated under Test *j*. There was a slight reduction of drum temperature, compared with test *i*, at points Nos. 1 and 3, but the rim temperature, at point No. 7, was practically unaffected. The effect of removing the dust shield was also tried, the original assembly of test *a* being used. The results are given under test *k*, and should be compared with those of test *a*. There was a considerable reduction of temperature at nearly all the points. Thus, at point No. 3 of the drum test *k* shows 152 deg. C. instead of 184 deg. C. in test *a*, while rim temperature, at point No. 7, was reduced from 97 deg. C. to 83 deg. C. Reductions at other points were also observed. The results tabulated under test *l* are from tests made with the dust shield in place but with a pipe, turned downwards inside the shield, through which air at the rate of 10 cub. ft. per minutes was introduced by a blower. Comparison of the results of test *l* with test *k* will show that, generally, the beneficial effect of a forced draught system was less than that of removing the dust shield. It is not, however, always practicable to run with the dust shield removed, though the results of test *k* show that when this can be done the benefits with respect to cooling are appreciable.

The four remaining tests in Table I are really check tests. Those for test *m* were made with a new drum similar to that used in test *a*. Comparison of the two sets of results will show that they are, for the most part, of the same order. The fitting of an inner ventilated wheel, similar to that already described, did not reduce the drum temperature, but resulted in a slight reduction of the rim temperature, these effects being less than those observed on the first drum. When both inner and outer wheels were ventilated there was only a slight further improvement. Similar results were observed at the higher rotational speed of 200 r.p.m. In general, it was found that the use of ventilated wheels did not reduce the air temperature within the clearance space, probably due to the small clearance between the rib and the rim. The use of eight radial vanes in conjunction with an inner ventilated wheel, however, resulted in some improvement, while, when these vanes were used with both inner and outer ventilated wheels there was a further appreciable reduction in temperature as will be evident from a comparison of the results of test *n* with those of test *m*.

The presence of the drum rib obviously interfered with the air flow through the clearance space while its complete removal resulted in an increase of drum temperature suggesting that a compromise between the two conditions might be advisable. Accordingly, the rib was turned down so that the clearance between its periphery and the inside of the rim was $\frac{1}{16}$ in., or approximately half way between the original clearance and that with the rib removed. With this increased clearance, compared with test *m*, the drum temperature was again found to rise, as will be evident from the results of test *o*, points Nos. 1 and 3, the arrangements for tests *m* and *o* being similar. The condition was repeated at the higher speed of 200 r.p.m. The partial removal of the rib was thus seen to be of doubtful value when used with unventilated wheels. But when using ventilated wheels in conjunction with eight radial vanes, the partially removed rib proved of service. This is the condition for which the results are given in test *p*, which should be compared with those of test *n*, this test being with the full depth rib. But the general benefits of the three major modifications, viz., (1) two ventilated wheels, (2) eight radial vanes and (3) the partial removal of the rib are most marked when test *p* is compared with test *m*. The former test is with all three modifications and the results of the latter one are derived from what is virtually the original arrangement of test *a*. The drum temperature reduction is 34 deg. C., *i.e.*, the difference between 176 deg. C. and 142 deg. C., at

point No. 3. The rim temperature reduction, at point No. 7, is 53 deg. C.; that of the tyre wall, at point No. 9, is 28 deg. C.; that of the brake lining, at point No. 14, is 38 deg. C.; and that of the axle casing, at point No. 17, is 19 deg. C. In every case these reductions would probably have an important effect on the durability of the parts concerned.

Apart from their intrinsic interest, the results recorded above are sufficiently encouraging to warrant a continuation of the work along similar lines. In this connection, arrangements have already been made to study the effect of brake drum diameter, together with the design of the external ribs. It would appear, for example, that two or more shallow ribs might be preferable to a single deep rib, provided that the ventilation in the clearance space is adequate.

MOULD AND CORE WASHES FOR DIE CASTING.

In recent years improved methods of manipulation and research in alloy compositions have resulted in greatly speeding up production and reducing costs in the pressure and gravity die-casting industries, but, to some considerable extent, the commercial success of these processes still depends on the care with which the surfaces of the expensive moulds and cores employed are maintained. For this reason a good deal of thought is given to the subject of mould and core washes and pasting media, the two principal properties required of the materials used being that they should be capable of resisting elevated temperatures and be free from any tendency to give off gas. Messrs. E. G. Acheson, Limited, 9, Gayfere-street, Westminster, London, S.W.1, inform us that their product, "Aquadag," consisting of colloidal graphite in water, is giving satisfactory service as a parting medium in the die-casting industry as it forms a slippery, inert and temperature-resisting graphite film on the surfaces of dies, moulds and cores. It is recommended that all faces to be coated should be first de-greased with white spirit, petrol, or other suitable solvent. The Aquadag is then diluted with approximately ten parts by weight of distilled water and the resulting liquid sprayed or brushed on to the cleaned mould surfaces. If the operation is carried out after a casting has been produced the residual heat in the mould and cores will drive off the moisture and leave a dry graphite film. It is stated that two or three successive applications of the wash should be made and the final coating lightly polished with a dry clean rag.

The need for subsequent applications of the wash depend, of course, on the throughput of castings, but it is stated that in some cases the coating will last for a considerable time and require only occasional light renewal by a quick brushing of the solution. In processes in which chilling of the cores between casts is adopted, a dilute solution, made up of one part of Aquadag in one hundred parts of water, may be employed as a core wash. Messrs. Acheson also inform us that a dispersion of colloidal graphite in oil is employed by certain manufacturers of die-casting equipment for the lubrication of external moving parts of the machines.

CATALOGUES.

Automatic Controllers.—Messrs. Negretti and Zambra, 122, Regent-street, London, W.1, have sent us a catalogue describing and illustrating their indicating and recording instruments for the automatic control of temperature, pressure, humidity, water level, etc.

Telerecorders.—For the remote measurement of flows, pressures and levels of water or other fluids, Messrs. George Kent, Limited, Luton, have developed "Telerecorder" installations, consisting of a transmitter, a mains unit, and one or more receivers, which are the subject of a pamphlet, No. 808/441, recently received.

Laboratory Machinery.—Messrs. Sturtevant Engineering Company, Limited, 147, Queen Victoria-street, London, E.C.4, have sent us a brochure describing crushing, grinding and screening plant for laboratory use. Those interested are invited to submit samples for treatment and to witness tests with the plant described.

Creep-Resisting Steels.—Messrs. Hadfields, Limited, East Hecla and Hecla Works, Sheffield, have sent us a catalogue dealing with steels of high creep resistance for use at temperatures up to 550 deg. C. Useful information is included regarding the behaviour of their special steels under such conditions, and particulars are given of their applications and manipulation.

Sewage Sprinklers.—A pamphlet received from Messrs. Ames Crosta Mills and Company, Limited, Moss Ironworks, Heywood, Lancashire, describes the "Simplette" revolving sprinkler adapted for use with septic or settling tanks. It is actuated by sewage flow through a water-wheel and bevel gearing, and is of a size suitable for small communities or country houses.

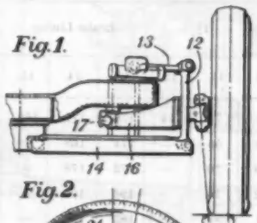
"ENGINEERING" ILLUSTRATED PATENT RECORD.

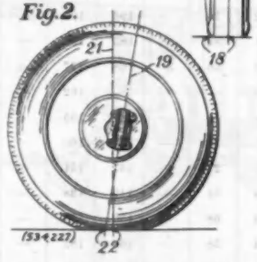
ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.
Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.
The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

MOTOR VEHICLES.

534,227. Steering Arrangement. The Rover Company, Limited, of Coventry, and P. A. Scott-Iversen, of Leamington Spa. (3 *Figs.*) August 28, 1939.—The invention is applicable to road vehicles fitted with low-pressure, wide-tread tyres, and having independent front suspension. When cornering, the outer front wheel rises relatively to the chassis-frame, and in so doing, its castor angle is increased, with the result that the steering then tends to be heavy. The invention is an arrangement for counteracting the castor effect when the vehicle is being cornered, thus making very light steering possible. The stub axle of the front wheel is mounted on the bracket 12 connected to the chassis-frame by links 13, 14. A radius rod 16 fast with the bracket 12 is connected to the chassis-frame by a ball joint 17. The "camber projection" 18





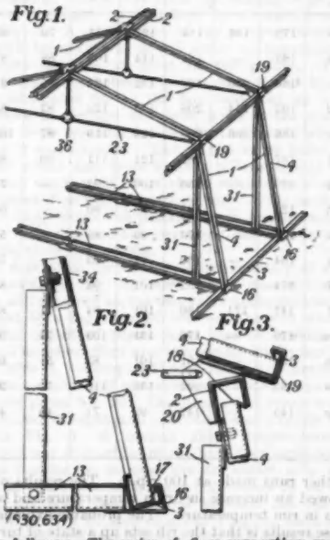
of the king-pin accords with normal practice. The king-pin axis 19, as regards castor angle, is at a materially greater inclination to the perpendicular 21 through the wheel centre, than is normal practice, and is well to the rear, though the "castor projection" 22 is a substantially normal one. With such an arrangement, a satisfactory castor effect will be obtained when the vehicle is being driven straight. When the vehicle is being cornered, the outside wheel rises relatively to the chassis-frame and the castor effect is counteracted by the tendency for the wheel to steer inwards due to the reaction of the ground introducing a couple which biases the wheel to turn about the king-pin axis in this direction. (*Accepted March 3, 1941.*)

RAILWAYS AND TRAMWAYS.

532,354. Railway Wagon. The Butterley Company, Limited, and J. L. Hogg, of Butterley. (2 *Figs.*) August 26, 1939.—The form of wagon referred to is intended for use on railways, pit tramways, etc., and obviates the use of separate framing members of rolled-steel section from which the wheels, springs, etc., are carried. The bottom of the wagon is built up from a number of floor plates which each extend the full width of the wagon. Each individual floor plate is a pressing and has integral side channel formations. Transverse vertical plates are secured between the meeting ends of the floor plates, and are extended beyond the integral side channels of the floor pressings so that the vertical stanchions of the sides of the wagon body can be welded on to their projecting ends. Where deeper channels are required on the middle sections of the wagon, part of the web and the bottom flange of the deeper channel is lapped over the adjacent end of the shallower channel, the bottom flange of the deeper channel being cut and bent upwards to the level of the bottom flange of the shallower channel. The two can then be welded together. At each end of the wagon is secured, between the two side channel formations, the headstock of the wagon to which the buffers are secured. When bottom doors are fitted, the centre section of the floor is in three separate pressings laterally, the centre pressing being bent to a channelled formation at the sides to form a bottom plate with integral centre longitudinal stiffeners, which carry the door hinge brackets. The axle guards, brake rigging and the springs which prevent the side doors from falling on to the brake rigging are all of standard construction and are secured to the integral channels. (*Accepted January 22, 1941.*)

MISCELLANEOUS.

530,634. Portable Building. Steel Ceilings, Limited, of **Hayes, Middlesex, and M. H. Briggs, of Coulsdon.** (21 *Figs.*) June 15, 1939.—The invention is a portable building in which no "loose" bolts and nuts are used in its erection, and which may be extended without structural modifications by the simple addition of standard parts or units. Identical frames 1 for the walls and roof are produced to the most suitable size from top and bottom members 2, 3, respectively, and a pair of uprights 4, all of sheet-steel channel. The floor is composed of planks nailed at each end to battens supported at their ends on transverse sheet-steel members 13, which rest on the ground. In length, these supports are somewhat less than half the width of the floor of the building having the smallest span proposed. At the outer end, each floor support has welded to its underside a horizontal plate with an upturned projection 16 terminating in an inturned lip 17, Fig. 2. The space between the outer end of a support 13 and the upturned projection 16 is sufficient to serve as a socket to accommodate the bottom member 3 of a frame 1. Pairs of channel-section clips 18, 19, Fig. 3, each pair connected by a welded vertical gusset plate 20, provide connections between the walls and roof of the building. The gusset plate is drilled to receive the hooked end of a tie rod 23. Those members 2 of the roof frames 1, which meet at the ridge of the roof are connected by a pair of channel-section clips arranged back-to-back and connected by a vertical gusset plate. Erection of the framework pro-



ceeds as follows:—The pairs of floor-supporting members 13 are laid on the site, and wall frames 1 are engaged by their lower ends 3 in the sockets between the upturned projections 16 and the ends of the floor supports 13, being hooked beneath the lips 17. The wall frames slope inwards at the top and are braced by vertical struts 31 hinged to the floor supports 13 so that, before erection of the building, they can be folded down to lie within the latter. The struts are secured to the uprights 4 by a captive bolt and nut at 34, Fig. 2. When the wall frames are in position, two of the pairs of clips 18, 19 are engaged over their upper ends. Roof frames 1 are then lifted into place and their lower ends engaged in the upper clips 19, their upper ends 2 meeting at the ridge of the roof. Two ridge connectors are clipped in position and the upper ends of two opposite roof frames 1 are engaged in the complementary sockets of the ridge connectors. The gusset plates 20 are connected by a pair of tie rods 23, the inner ends of which are hooked into holes in a connecting plate 36 suspended from the gusset plate of a ridge connector. The framework thus produced constitutes a single-span unit, and is clothed externally with corrugated steel sections, each corrugation accommodating an upright 4 of a frame 1. The walls can be lined with insulating board attached to the struts 31. The building can be lengthened by the simple addition of further units, and the span can be varied by connecting two or more roof frames end to end on one or both sides of the ridge. (*Accepted December 17, 1940.*)